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Chapter 1

INTRODUCTION

Recent years have seen an awakening in the public's environmental consciousness. The sight of the Apollo program's image of the earth as a discrete sphere, isolated in space, has helped to lead to an awareness of the limits to natural resources and the need for wise resource management. It has become clear to many people that resource conservation and maintenance of environmental quality play a vital role in the overall quality of human life.

Responding to public concern, the federal and state governments have imposed increasingly stringent water quality and waste discharge standards and have made cost sharing funds available for construction of wastewater treatment facilities. To ensure that the available funds are used in a way that will maximize environmental improvement, the federal government requires that states conduct basin-wide water quality management studies that will provide a basis for sound planning and implementation of water pollution control programs. The Utah Lake-Jordan River Hydrologic Basins Water Quality Management Planning Study is designed to meet these requirements. The geographic location of the basins with respect to the state is shown in Figures 1-1 and 1-2.

In common with many other rapidly urbanizing areas, the Salt Lake City-Provo-Orem metropolitan area, central to the economy of the basins, is facing many environmental problems associated with rapid development and changing land uses. Few urban areas can offer residents such easy access to unspoiled canyonlands, mountains and outdoor recreation areas. This very closeness of city and mountain, however, makes sound resource planning and management imperative if the natural advantages of the area are to be preserved.

Maintenance of water quality becomes difficult as more and often conflicting demands are imposed on the water resources. The need for high quality water for supply to the cities conflicts with the desire to develop recreation areas and second-home developments within the water supply catchments. The need to dispose of municipal and industrial wastes in waterways conflicts with the desire to use these waterways for aesthetic

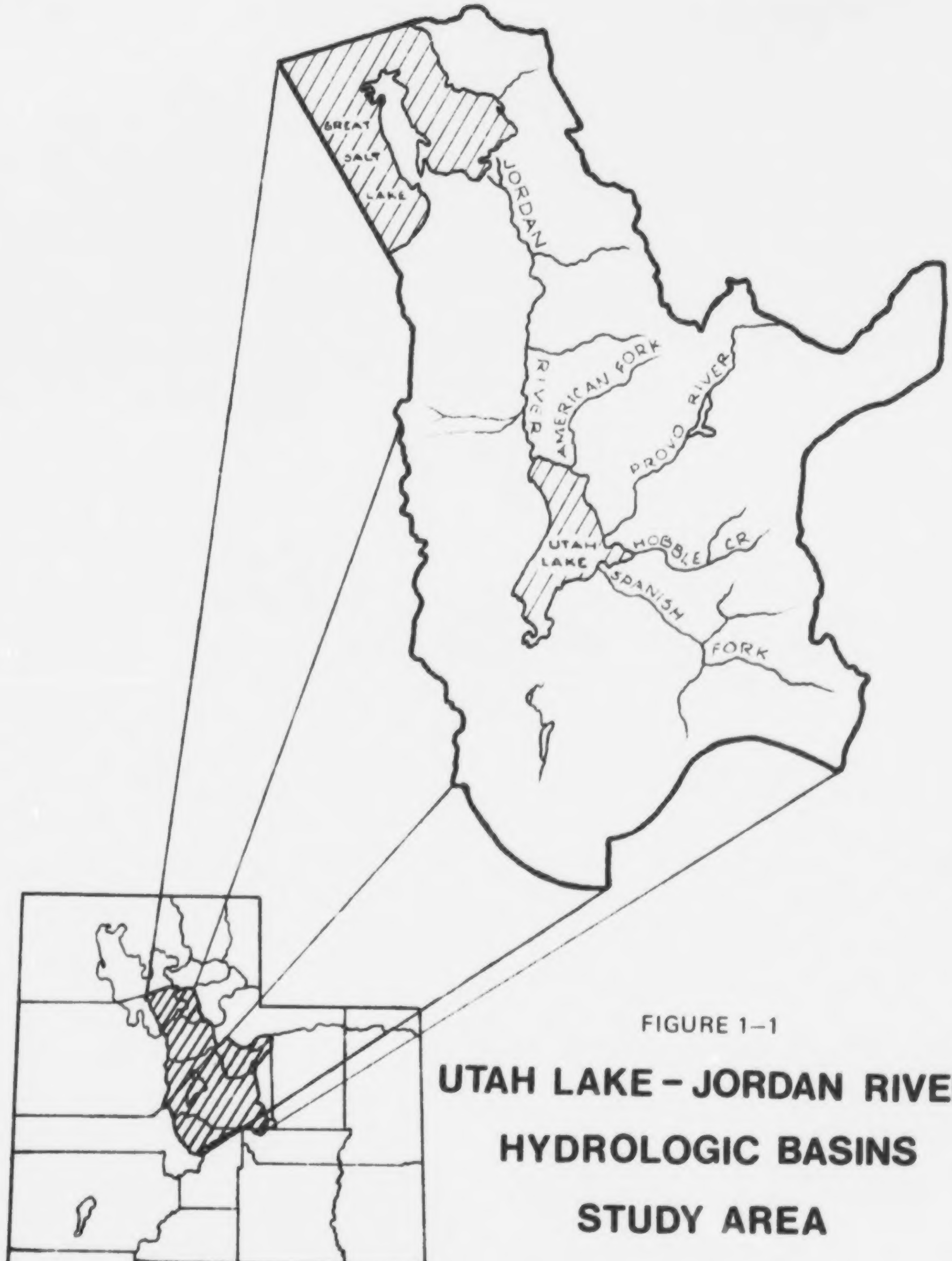
GREAT SALT LAKE
JORDAN
RIVER
AMERICAN FORK
PROVO RIVER
UTAH LAKE
HOBBLE CR
SPANISH FORK

FIGURE 1–1

UTAH LAKE – JORDAN RIVER
HYDROLOGIC BASINS
STUDY AREA

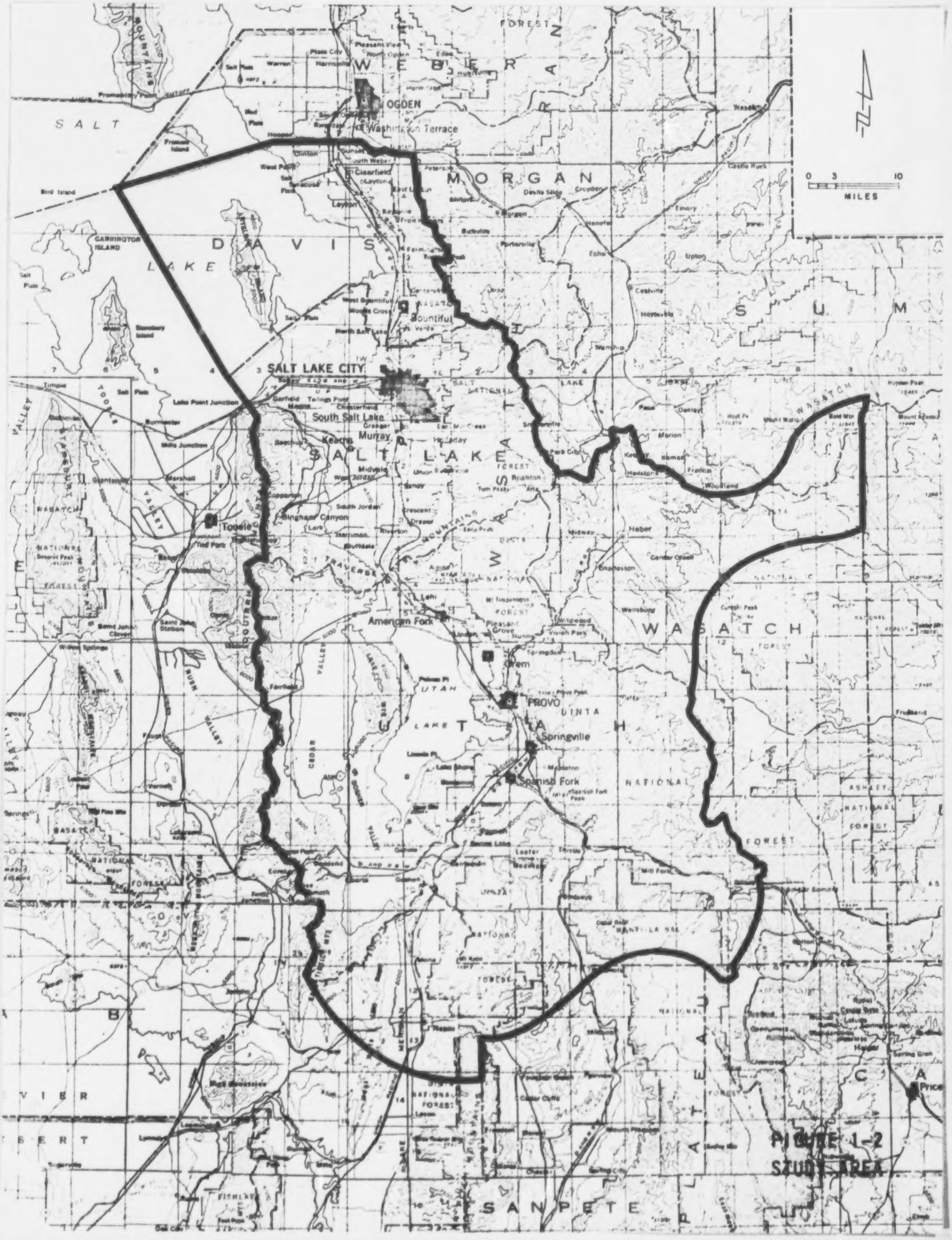
WEBER
OGDEN
Washington Terrace
MORGAN
DAVIS
SALT
LAKE
SALT LAKE CITY
South Salt Lake
Murray
SALT LAKE
Bountiful
Tooele
WASATCH
American Fork
Orem
PROVO
Springville
Spanish Fork
UTAH
UINTA
NATIONAL
FOREST
SUM
SANPETE
CEDAR
Price
0 3 10
MILES

FIGURE 1-2
STUDY AREA

enjoyment and recreation. Diversion of water for irrigation of crops drastically reduces flow in the lower reaches of many of the streams and consequently diminishes their usefulness for other purposes. Clearly, if an equitable balance between these and many other demands for beneficial use of the water resource is to be found, then a thorough study must be conducted to determine the best way to utilize the available resources while maintaining an acceptable level of water quality.

GOALS AND OBJECTIVES

The basic purpose of the study is to develop a comprehensive plan that will serve as a framework for future water quality planning and control activities within the Utah Lake-Jordan River Hydrologic Basins.

The plan complies with federal regulations for basin plans as defined in Section 303(e) of the Federal Water Pollution Control Act as amended in 1972; a prerequisite to the award of federal grant monies to cities and districts for construction of wastewater treatment facilities.

The plan identifies and describes the facilities and institutional arrangements necessary to attain the water quality standards established by the State of Utah.

The plan provides the basis for the issuance of waste discharge permits under the National Pollutant Discharge Elimination System.

The plan provides a basis for establishing priorities in the disbursement of funds for the construction and upgrading of wastewater treatment facilities.

PUBLIC PARTICIPATION

Planners may develop technically and environmentally sound plans, but the public must participate in the selection of the best alternative if the recommended plan is to gather the public support necessary for its implementation. The need for public participation in water quality management planning is recognized in a provision of the Federal Water Pollution Control Act.

Every effort was made during the study to comply with this provision by holding both public meetings and meetings with special interest groups.

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Progress of the study and the method for evaluating alternatives were described at the earlier meetings. Alternative courses of action were described and discussed at the meetings in January, 1974. Many informal meetings with special interest groups were held during the study period particularly in the later stages as the plan was formulated. The location and dates of formal public meetings are shown below:

Heber	17 September 1973
American Fork	27 September 1973
Farmington	11 October 1974
South Salt Lake City	7 November 1973
Heber	7 January 1974
South Salt Lake City	9 January 1974
Farmington	10 January 1974
Provo	11 January 1974

The recommended water quality control plan was the subject of a joint public hearing held in Salt Lake City on October 3, 1974 by the State Water Pollution Committee and the State Board of Health.

ORGANIZATION AND CONDUCT

The Utah Lake-Jordan River Water Quality Management Study was sponsored by the State of Utah acting through the Department of Social Services, Utah State Division of Health, Bureau of Environmental Health. The study was financed, in part, through a planning grant from the Environmental Protection Agency under the provisions of subsection 102 (C) of the Federal Water Pollution Control Act, as amended.

In December 1971 the Utah State Division of Health, Bureau of Environmental Health contracted with Templeton, Linke and Alsup, Consulting Engineers, to conduct the water quality management study. Three organizations were awarded subcontracts to provide technical assistance to the program; Engineering-Science, Inc., the University of Utah Engineering Experiment Station and Ford Chemical Laboratory.

During the first eighteen months of the planning program, Engineering Science, Inc. was employed in an advisory capacity to provide special technical expertise. In the latter months of the study, Engineering-Science assumed a more dominant role taking co-responsibility for developing and evaluating alternative water quality management strategies and report preparation.

The University of Utah Engineering Experiment Station compiled flow measurements of the major streams. Ford Chemical Laboratory analyzed water samples.

Technical assistance in support of the program was provided by the Utah State Division of Health, Bureau of Environmental Health and Division of Health Laboratories, the Utah State Department of Natural Resources, Davis County Health Department, Salt Lake City-County Health Department, Utah County Health Department, Wasatch County Health Department, Utah State University Water Research Laboratory and Salt Lake County Model Cities Agency. Funds expended by these agencies are considered as part of the local funding of the study to match the federal grant.

Throughout the two and one-half year study, planning activities were guided by two groups-the Study Management Committee and the Study Advisory Board. The Study Management Committee meetings, generally held at two week intervals, provided a forum for discussion of detailed plan elements between the State Division of Health, Bureau of Environmental Health and the study contractors. Members of the committee are listed below:

Study Management Committee

Prof. Grant K. Borg, Chairman, Utah State Water Pollution Committee

Lynn M. Thatcher, Deputy Director, Utah State Division of Health

Calvin K. Sudweeks, Chief Engineer, Water Quality Section, Utah State Division of Health

Richard C. Hansen, Assistant Chief, Water Quality Section, Utah State Division of Health

Howard W. Hurst, Director, Bureau of Environmental Health, Utah State Division of Health

Michael L. Miner, Ph.D., Environmental Scientist, Utah State Division of Health

Keith W. Welch, Environmental Scientist, Utah State Division of Health

LaVere B. Merritt, Ph.D., Environmental Consultant to Utah State Division of Health

Harold A. Linke, Jr., President, Templeton, Linke and Alsup, Consulting Engineers

Garth R. Morgan, Ph.D., Project Manager, Templeton, Linke and Alsup, Consulting Engineers

Philip N. Storrs, Senior Vice President, Engineering-Science, Inc.

John A. Davis, Project Manager, Engineering Science, Inc.

The Study Advisory Board included representatives of governmental agencies concerned with environmental quality. The board generally met bimonthly to review progress of the study and to advise on local issues. Members of the board are listed below:

Prof. Grant K. Borg, Chairman, Utah State Water Pollution Committee

Calvin K. Sudweeks, Executive Secretary, Utah State Water Pollution Committee

Max A. Dodson, Planning Branch, U.S. Environmental Protection Agency

Paul Ferraro, Planning Branch, U.S. Environmental Protection Agency

James S. Cochrane, U.S. Forest Service

Lee J. McQuivey, U.S. Army Corps of Engineers

James C. Mundorff, U.S. Geological Survey

Sheldon H. Talbot, U.S. Bureau of Reclamation

John W. Jensen, U.S. Bureau of Land Management

W. Vee Call, Director, Provo-Jordan River Parkway Authority

Grover Thompson, Utah State Planning Coordinator

Christian P. Beck, Utah State Department of Community Affairs

Jay M. Bagley, Ph.D., Director, Utah State Water Research Laboratory

Rodney Sutton, Director, Davis County Planning Commission

Clayne J. Ricks, Director, Salt Lake County Planning Commission

Carl M. Johnson, Director, Utah County Planning Commission

Dale R. Berg, Director, Wasatch County Planning Commission

Ivo D. Mills, Chairman, Land Use Planning Wasatch Front Regional Council

William L. Davis, Wasatch Front Regional Council

George Scott, Executive Director, Mountain Lands Association of Governments

Larry Jensen, Director, Salt Lake County Environmental Health Services

Harry L. Gibbons, M.D., Director, Salt Lake City-County Health Department

Harold A. Linke, Jr., Project Director and President, Templeton, Linke and Alsup, Consulting Engineers

Philip N. Storrs, Project Director and Senior Vice President, Engineering-Science, Inc.

Dr. LaVere B. Merritt of the Bureau of Environmental Health served as principal study coordinator. Project managers for Templeton, Linke and Alsup and Engineering-Science, Inc. were Dr. Garth R. Morgan and Mr. John A. Davis respectively.

The assistance of many state, county and local officials and concerned individuals too numerous to mention, is gratefully acknowledged.

CHAPTER 2

SUMMARY

The summary of the report narrative and the recommended plan is prefaced by a brief description of the study process which is illustrated in Figure 2-1.

The initial study elements include the information acquisition necessary to develop a detailed picture of the study area, present water quality in the rivers and streams and the sources of pollution-causing wastes. Present and future waste loads to be imposed on the streams were estimated and the level of waste treatment and dispersion necessary to maintain an acceptable level of water quality was determined. Alternative ways of handling municipal wastewaters were synthesized and evaluated with respect to cost, environmental factors, feasibility and overall effectiveness. Public meetings were held to discuss the alternatives and a generally acceptable plan was selected.

Chapters 3 through 14 which describe the study elements are summarized in the following paragraphs.

THE NATURAL ENVIRONMENT

The study area is comprised of the Utah Lake and Jordan River drainages, bounded on the east by the Wasatch Mountains, and on the West by the Oquirrh and East Tintic Mountains. Steeply rising mountains on the east, a relatively flat valley floor, benched foothills and the freshwater Utah Lake draining via the Jordan River into the Great Salt Lake are some of the contrasting natural features contributing to the complexities of water quality management.

The climate of the study area is semi-continental and semi-arid. Most precipitation occurs as snow in the winter, ranging in total from 12 to 60 inches. Daily temperatures vary widely but are moderated by the high mountains and the Great Salt Lake. Average annual temperatures range from 36°F in the Wasatch Mountains to 51°F near the Great Salt Lake. The corresponding frost-free season ranges from 102 to 143 days.

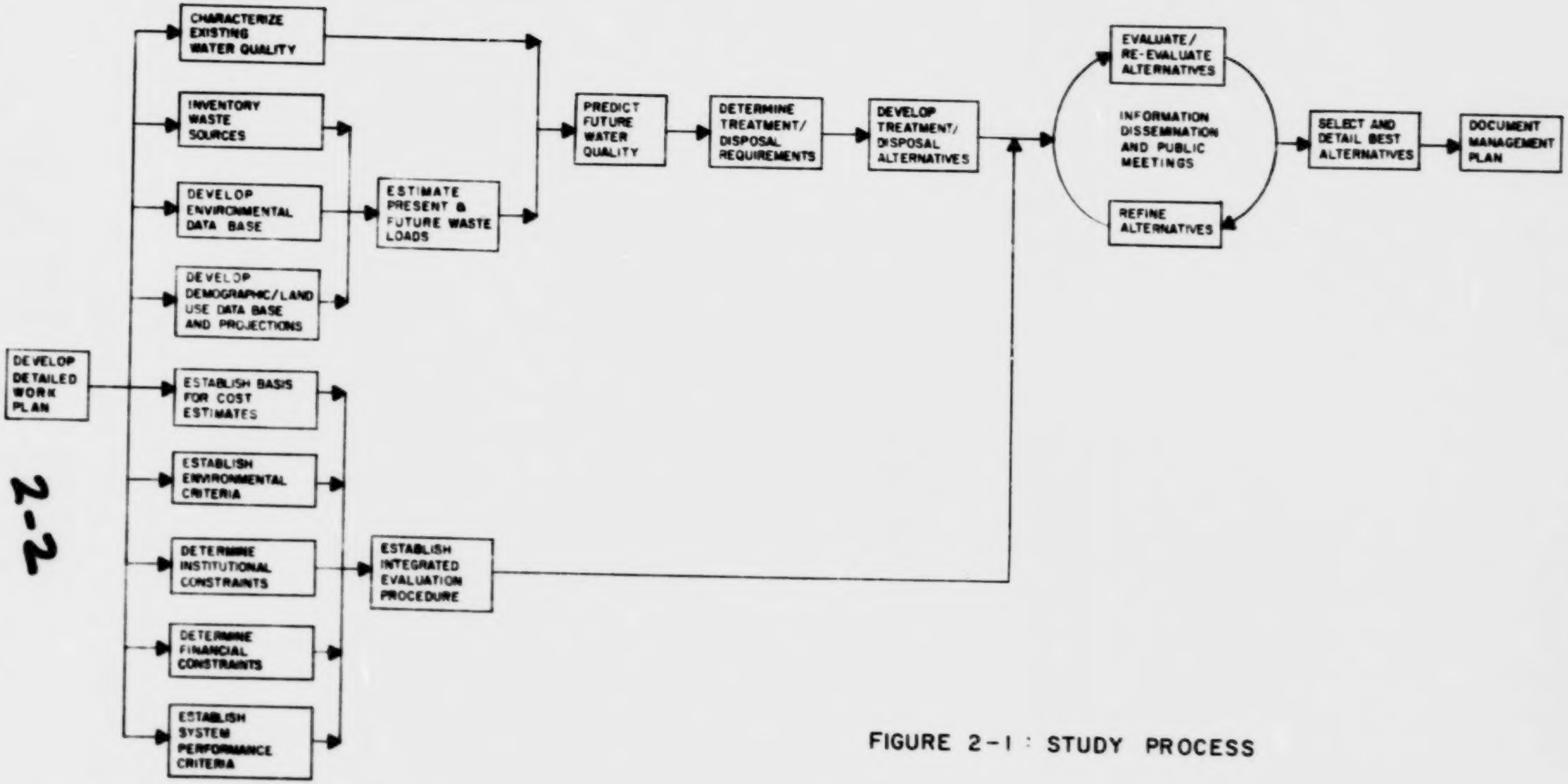

DEVELOP DETAILED WORK PLAN
CHARACTERIZE EXISTING WATER QUALITY
INVENTORY WASTE SOURCES
DEVELOP ENVIRONMENTAL DATA BASE
DEVELOP DEMOGRAPHIC/LAND USE DATA BASE AND PROJECTIONS
ESTABLISH BASIS FOR COST ESTIMATES
ESTABLISH ENVIRONMENTAL CRITERIA
DETERMINE INSTITUTIONAL CONSTRAINTS
DETERMINE FINANCIAL CONSTRAINTS
ESTABLISH SYSTEM PERFORMANCE CRITERIA
ESTIMATE PRESENT & FUTURE WASTE LOADS
ESTABLISH INTEGRATED EVALUATION PROCEDURE
PREDICT FUTURE WATER QUALITY
DETERMINE TREATMENT/ DISPOSAL REQUIREMENTS
DEVELOP TREATMENT/ DISPOSAL ALTERNATIVES
EVALUATE/ RE-EVALUATE ALTERNATIVES
INFORMATION DISSEMINATION AND PUBLIC MEETINGS
REFINE ALTERNATIVES
SELECT AND DETAIL BEST ALTERNATIVES
DOCUMENT MANAGEMENT PLAN

FIGURE 2-1 : STUDY PROCESS

The Salt Lake and Utah Valleys were covered by the ancient Lake Bonneville during the glacial epoch. As the surface of the lake gradually fell, the accompanying erosion produced the characteristic landforms visible today, while laying unconsolidated materials to great depths under the present-day valley floors. The soils eventually formed on the lake deposits and alluvial materials range from coarse, well-drained soils in the mountain areas to heavy clays with poor drainage and high-organic matter near the Great Salt Lake, along the Jordan River, and in other low-lying areas.

Approximately 480 miles of surface streams drain the basin into many lakes and reservoirs. Utah Lake is the largest freshwater body in the basins, serving primarily as a water supply reservoir for agriculture. Its quality has been degraded somewhat by municipal, agricultural, and other wastewaters.

A prominent feature of the Study Area, the final repository of all wastewater residues, is the Great Salt Lake, a closed, shallow, saline remnant of old Lake Bonneville.

Groundwater in the Study Area occurs in two hydrogeologically separate basins: the Salt Lake and Utah Valleys. Annual discharge from the Salt Lake Valley basin is approximated to be 300,000 acre-feet per year. Recharge comes from seepage in streambeds, excess irrigation and mountain front drainage.

The highly saline Great Salt Lake can only support a few plant species (11 bacteria and 4 algal species) and even fewer animals (protozoa and brine shrimp species). Several species of birds inhabit the islands of the Great Salt Lake and forage the marshlands of Farmington Bay and Utah Valley. At least 49 native and introduced fish species are recognized in the waters of the Study Area, some of which face the danger of extinction. The terrestrial ecology of the Study Area includes several major desert biotic communities with the mammals of the desert common to each habitat.

POPULATION, LAND USE AND ECONOMY

The population of Utah Lake-Jordan River basins is about 68 percent of the total population of the State of Utah and at present stands at about 719,000 persons. Nearly two-thirds of the people in the Study Area are concentrated within the Salt Lake Metropolitan Area (Salt Lake County). A general shift from rural to urban living has given rise to a marked increase in city populations, with an attendant 39 percent decrease in rural population over the decade of 1960 to 1970. Population projections for the study period (through 1995) were based upon economic and demographic trends of the recent past, resulting in an anticipated doubling of urban populations. Increases in various subareas are projected to range from 67 to 143 percent between 1970 and 1995.

Slightly over half of the land area is owned privately, while 31 percent is managed by the U.S. Forest Service and the remainder is in various other public ownership categories. Over two-thirds of the area is in forests, about 17 percent is cultivated, 8.4 percent is vacant and 1.9 percent is in residential use. The remainder of the land area is under roadways, parks, institutions, industries, utilities and commercial uses. It is envisioned that major increases in residential and commercial uses, as well as institutional land requirements, will occur during the study period. Agricultural land use is expected to decrease.

The diversified economy of the Study Area has grown substantially and steadily in recent years. The outlook for the years ahead is for continued expansion. Natural resources, such as copper, steel and oil are abundant in Utah and the pace of agricultural production has been rapid. Manufacturing industries have recently grown to attain second place in the income-producing sector of the economy. Service industries, too, have grown faster than the national economic growth rate.

EXISTING WASTEWATER COLLECTION, TREATMENT AND DISPOSAL FACILITIES

Community wastewater systems serve about 94 percent of the area's population while the remaining 6 percent reside in unsewered areas that rely on individual underground disposal systems. Industrial wastes are either treated and disposed of by the individual industries, or discharged to a municipal sewerage system. These systems are operated either by the municipalities or by special improvement districts.

Municipal wastewaters are treated in 29 secondary treatment facilities predominantly utilizing the trickling filter process. There are 4 plants in Davis County, 13 in Salt Lake County, 9 in Utah County, 2 in Wasatch County, and 1 in Juab County. Average flow to all plants totaled 115 million gallons per day (mgd) in 1972 and the aggregate design treatment capacity of the plants is 152.4 mgd.

Industrial wastewater discharges were briefly regulated by the U.S. Army Corps of Engineers from 1968 through 1972. The Corps' responsibility for issuing permits for all discharges to navigable waters and their tributaries has been transferred to EPA. A significant portion of industrial flows--mostly effluents from cooling and washing operations containing negligible pollutants--receive no treatment. Oily effluents are treated in API separators and settling ponds. Some industries also use oxidation ponds, dissolved air flotation, neutralization, trickling filters and chorination.

FINANCIAL ARRANGEMENTS FOR WASTEWATER COLLECTION, TREATMENT, AND DISPOSAL

Sources of revenue to finance initial investments, system operation and maintenance and capital improvements of public sewerage facilities are: property and sales taxes, sewer service charges and connection fees. Maximum property tax rates are established by the laws of the State of Utah for each type of entity providing sewerage service. Tax rates are applied to assessed valuations which are computed as 30 percent of the fair cash value of property owned by individuals and corporations (with minor exceptions).

Major capital improvements are generally financed by issuance of general obligation bonds, revenue bonds, and long-term contracts. General obligation bonds are based upon the total assets of the public entity issuing them. Hence, they represent the most favorable type of credit and are usually bought at lower interest rates than other types of bonds. Revenue bonds rely for repayment upon service charges collected as a result of operation of the facilities financed. Long-term contracts are rarely used in the Study Area, but they comprise an available means of providing sewerage service to a community by purchasing treatment or conveyance capacity in another entity's existing facilities.

Each city, county, improvement or other district in the State of Utah is restricted by law as to the debt ceiling it can incur. The limit ranges between two and 12 percent of the fair cash value of property within the boundaries of the entity involved. These limits, and the present outstanding debts of each entity determine the ability of that entity to incur further debt where necessary for water quality control schemes for further bonding for the study area.

Section 202 of the Federal Water Pollution Control Act provides for grants of 75 percent of the construction costs of treatment works to local agencies by the Federal government. The construction grants available from EPA are administered by the Utah State Division of Health. Future approval of grants is contingent upon adoption of basinwide water quality managment plans such as the present plans.

WATER USE AND WASTE LOADS

In the basin, water is used principally for municipal, industrial, agricultural and recreational purposes. Agriculture accounts for some two-thirds of the total water use and industry takes up half of the remaining one-third. Agricultural water requirements are by far the greatest in Utah County while the major municipal, industrial and recreational water uses occur in Salt Lake County where urbanization is greatest. The greatest increases in projected water use are expected to occur in the municipal and industrial categories, principally in Salt Lake County. Agricultural water uses are expected to diminish--rather slowly--throughout the Study Area due to urban capture of previously irrigated lands. Recreational water uses, for park and golf course irrigation, are expected to increase in Davis, Salt Lake and Utah Counties while remaining a relatively small proportion of the total water requirements.

Waste loads generated in the Study Area were estimated principally from liquid waste flows and average concentrations of four major pollutant constituents: five-day biochemical oxygen demand (BOD_5), total dissolved solids, total phosphate and nitrogen. Approximately 97 percent of the total municipal wastewater flow (about 116 mgd) is collected, treated and disposed of to the surface waters. The remainder percolates into the groundwater from septic tank systems. Before treatment the mass emission rates amount to 22,400 pounds per day (lb/day) of BOD_5, 666,000 lb/day of dissolved solids, 29,300 lb/day of nitrogen and 23,800 lb/day of phosphorus. Substantial removal of BOD is accomplished in the treatment processes employed by the various communities. However, little nutrient removal is achieved at the present time. Industries in the basins discharge a total of 193,000 lb/day of BOD into the municipal systems and 43,000 lb/day directly into the streams.

The character of wastewaters originating in storm runoff is somewhat more elusive due to the rapidly changing character of the pollutant concentrations during the relatively short storm runoff periods; however, runoff from urban areas is a serious source of pollution in the basins. Estimates were based upon weighted average pollutant concentrations and rainfall and runoff data. It is estimated that, averaged over the entire year, urban runoff contributes a total of 9,150 lb/day of BOD_5, 405,000 lb/day of TDS, 2,670 lb/day of nitrogen and 840 lb/day of phosphorus. Of course, the loadings are much higher during the storm runoff periods.

Agricultural waste loads were based on irrigation flow rates, consumptive use by plants, surface runoff, properties of various soils groups, and the average quality of runoff and deep seepage waters, In spite of the large volumes of wastewater emanating from agricultural irrigation, mass emission of pollutants from this source does not contribute an overwhelming amount of pollutants to the surface waters in most parts of the Study Area. Agricultural wastewater contributions are greatest in Utah County, where they comprise 16 percent of the total BOD_5, 68 percent of the TDS, 25 percent of the nitrogen and 7.5 percent of the phosphorus.

In the overall study area, for the raw wastewaters, municipal wastewaters represent 22 percent of the 522 mgd total waste flow and 52 percent of its BOD_5. Discrete industrial discharges account for 31 percent of the daily flow, 17 percent of the BOD_5 and 43 percent of the TDS. Irrigation return flow represents 34 percent of the daily flow and 22 percent of the total solids. Most of the nitrogen and phosphorus is contributed by municipal wastewaters.

Projections of future wastewater flows are made on the basis of population projections, predictions of industrial growth and agricultural decline and assumed changes in unit waste generation rates. Basin-wide projections for wastewater flow indicate a relatively large increase in municipal flows, little change in overall industrial flows, a slight decline in agricultural flows and a moderate increase in urban runoff. Total wastewater flow is expected to increase from 522 mgd in 1972 to 616 mgd in 1995.

WATER RESOURCES DEVELOPMENT

The arid climate of the Study Area and its limited water resources have brought about a high level of water resource management. Extensive reservoirs and canal systems are used for storage and conveyance of water for use at various locations.

Major suppliers of potable water in the Study Area include the Weber Basin Water Conservancy District, Salt Lake County Water Conservancy District, Metropolitan Water District, Salt Lake City Water Department, Provo City Water Department, Orem City Water Department, and the Central Utah Water Conservancy District. Irrigation water is supplied by 192 irrigation companies.

The large diversions of water from the Jordan River have given rise to a substantial flow reduction downstream. Thus, the dilution capacity of the stream for agricultural wastewaters and other effluents discharged into it has declined substantially.

Total water use in the Utah Lake-Jordan River Basins is estimated to be 1,491,000 acre-feet per year (1,330 mgd). Total water use is expected to increase by 30 percent between now and the year 2020. Most of the increase is expected to occur in Davis and Salt Lake Counties.

Most local sources of water have been fully developed and transfers from other basins supply about one-fifth of the present total demand. Much of the area's future water supply must also be imported from outside the basins. To this end, several inter-basin water resource transfer projects are in planning and implementation stages of development. The Central Utah Project (CUP) is a major statewide effort designed to make additional water available to the urban areas near Salt Lake City and

Provo through a series of dams, reservoirs and aqueducts. When complete, the CUP will deliver approximately 136,000 acre-feet of additional water per year from the Uinta Basin to Strawberry Reservoir and hence into the Wasatch front areas.

Water quality in the Study Area will be generally improved as a result of importation of water from other basins. The improvement is due to the superior quality of the imported water sources and the increased capacity for waste assimilation. The several large reservoirs planned in the basin headwaters, in Wasatch County, are expected to maintain a high level of water quality as long as land use in their watershed is rigorously controlled. Implementation of the CUP will also allow augmentation of minimum flows in the Jordan River during the summer irrigation season and in winter when very low flows are encountered in some reaches of the river.

WATER QUALITY STANDARDS AND CONTROL STRATEGIES

Many government agencies, Federal, State and local, are involved in the regulation of water quality. At the federal level, the U.S. Environmental Protection Agency is charged with the responsibility for implementing the provisions of both the Federal Water Pollution Control Act as amended in 1972 and the National Environmental Policy Act of 1969 and for administering the federal construction grant program for wastewater facilities.

Within the State of Utah the Utah State Division of Health and the State Water Pollution Committee have primary responsibility and authority to prevent waste disposal practices from becoming a hazard to health or a detriment to water quality.

Local agencies, industries and individuals are obligated to finance, build and operate wastewater facilities that will provide an acceptable means of waste disposal and meet all applicable water quality standards.

Federal regulations are based on the Federal Water Pollution Control Act Amendments of 1972. The 1972 Act established as a national goal that the discharge of pollutants into the navigable waters of the United States be eliminated by 1985, and that, as an interim goal, where ever attainable, there be achieved by 1 July 1983 water quality which provides for the protection and propagation of fish, shellfish and wildlife and provides for recreation in and on the water.

It is recognized by EPA that while the 1983 goal is an objective which carries with it defined, specific, enforcement mechanisms, the 1985 goal is an ideal toward which Congress intended the country to strive. To reach these goals, the Act requires that waste discharges must be of a specified, improved quality before release to the receiving water. To assure that the improved quality is attained, new authority is given to federal and state governments to fully develop a national permit system to regulate the quality of discharged wastes.

The Utah Water Pollution Committee and the Utah State Board of Health are empowered by the state legislature to establish water quality criteria and enforce water quality standards in the State of Utah. These bodies have defined several classes or levels of stream water quality and have assigned classifications to all surface waters of the State. In June 1972, the Utah Water Pollution Committee and the Utah State Board of Health issued an order classifying all intrastate surface waters in the State as Class "C". The compliance schedule adopted in 1974 required that all discharges must be altered, as necessary, to meet the standards by 30 June 1983. As an interim measure all dischargers must provide effective secondary treatment or the equivalent by 30 June 1977. Additional more stringent interim effluent standards were also adopted that must be met by 30 June 1980.

Control tactics for the basins, designed to meet the water quality requirements, include the establishment of water quality planning criteria, classification of stream segments, allocation of waste loads and regulation of waste discharge through the permit program (National Pollutant Discharge Elimination System).

PRESENT WATER QUALITY

Each body of water in the study area presents unique water quality conditions and problems, revealed through the sampling programs conducted by the various regulatory and academic entities as well as in the course of the present study. During the conduct of this project, 107 stations on canals, rivers, plant effluent streams and other water bodies were regularly sampled and analyzed for physical, chemical and biological characteristics Results were compared against standards and criteria established earlier. The water quality problems encountered--and the causes and parameters used to measure them--were analyzed in all parts of the study area, with special emphasis on oxygen depletion, nutrient enrichment, excess salinity, bacteriological contamination, toxicity and biotic degradation.

Generally, the undeveloped upstream reaches of nearly all streams in the study area have high quality waters. As the streams flow through rural and urban areas, water quality gradually deteriorates. In the final reaches, before discharge to Deer Creek Reservoir, Utah Lake, and the Great Salt Lake, as well as along the entire length of the Jordan River, stream quality generally falls below Class "C" water quality standards. Specific instances of excessive pollutant concentrations abound in the various reaches of most streams in the basin. High levels of nitrates are found in all of the major tributaries of the Jordan River and Utah Lake. Measurable oil and grease throughout the length of the Jordan River and in the downstream reaches of many of its tributaries originate in urban runoff.

Benthic diversity index is generally low in the downstream reaches in warm seasons and relatively high in the winter. The natural seasonal cycles are intensified by the shifting of the substrate due to agricultural erosion of silts and sands and variations in dissolved oxygen brought about by organic waste discharges.

Despite the heavy pollutant loadings entering Utah Lake, its size is sufficient to dilute and degrade many constituents to a minimal level. Thus, with the exception of several bay and near-shore areas, Utah Lake water remains relatively unpolluted, though endangered by continuous discharges of sediments, fertilizers, and pesticide-laden flows. A number of fish species which resided in Utah Lake have been reduced in population, disappeared from the lake or become extinct altogether. The reduced species diversity coupled with the large input of nutrients indicates that the lake is now very eutrophic.

Only a few significant water quality problems were found in Wasatch County streams, although some instances of oil, biochemical oxygen demand, nutrient enrichment and radiological pollution are observed. These problems were generally directly attributable to rather obvious sources such as inadequate sewage treatment and barnyard drainage.

WASTE DISPOSAL AND WATER QUALITY

Water quality may be altered in a multitude of ways. Historically most of the alterations resulting from man's activities have led to degradation of water quality and limitation of water use. Efforts have been made during the last century to slow or halt the rate of water quality degradation by the introduction of engineered wastewater collection, treatment and disposal systems. While these measures have, in fact,ameliorated water pollution, water quality in many of the streams in the study area remains below that level which will support a wide range of beneficial uses.

Four principal ways of improving water quality exist: source control, waste treatment, relocation of disposal sites and in-stream quality/quantity modification.

Source control measures are actions that alter or eliminate a waste at or near its source. Examples of source control measures are industrial process changes that reduce the volume and strength of waste streams, good street-cleaning practices that reduce the pollutional potential of urban runoff, and design and management of livestock corrals to minimize generation of polluted runoff. Waste treatment is the processing of a discrete waste stream in order to alter its physical, chemical or biological characteristics. Relocation of a waste disposal site can alter the environmental impact of the discharge. Stream water quality may be altered by flow augmentation or in-stream treatment.

For the purpose of the study the four municipal treatment or effluent quality levels were chosen for use as planning guides. These levels of effluent quality can be achieved by a number of different process trains.

Effluent quality level I is a typical secondary effluent such as might be produced by high-rate trickling filter or activated sludge plants. Effluent quality level II is a high-quality nitrified or at least partially nitrified secondary effluent. Effluent quality level III is a nitrified secondary effluent from which some of the residual particulate matter has been removed. Effluent quality level IV is a nitrified effluent from which almost all the particulate and oxygen-demanding matter has been removed.

To develop an effective water quality management plan, it is necessary to predict the effect of these water quality modification measures on the receiving waters of the study area. Water quality models were used to accomplish this, and to evaluate various levels of treatment and treatment consolidation with respect to applicable water quality standards.

EVALUATION PROCEDURES

The best water quality management alternative is one that reliably protects and enhances water quality in an economic and resourceful manner.

The costs incurred by and benefits received from each water quality management alternative must be evaluated in an equitable and systematic fashion as a prerequisite to rational decision making. Some of the costs and benefits, costs of construction of treatment facilities for example, can be calculated fairly simply since society places a readily identifiable value on the labor and materials necessary for their construction and operation. Difficulties arise, however, when the less tangible aspects of the alternatives are evaluated. What is the value of sparkling clear stream water, safe swimming water, a breathtaking view, or the continued existence of some aquatic insect? Clearly the values placed on these elements will be as widely varied as the many individuals whose lives they affect in different ways. How can these factors be introduced into the decision-making process?

The procedure developed for use as a tool in this study is designed to provide a rational framework within which all the evaluations can be made. Each water quality management alternative is evaluated with respect to four groups of factors: economics, environmental effects, feasibility and effectiveness. Economic evaluation is straightforward once a common basis for calculation has been established. Evaluation of environmental effects, feasibility and effectiveness is subjective, reflecting the preferences, prejudices and opinions of the evaluator. The key to systematic evaluation of the not readily quantifiable factors is the development of an evaluation matrix which will serve as a basis for discussion and rating of alternative courses of action.

The relative importance or weight of the various factors within the matrix was determined by the members of the Study Advisory Committee.

WATER QUALITY MANAGEMENT ALTERNATIVES

Municipal wastewater management alternatives were developed for several sub-areas. Thirteen alternatives were evaluated for Davis County, twelve each for Salt Lake County, Northern Utah County and Central Utah County and six for Wasatch County. A further six alternatives that included both Utah and Wasatch Counties were considered.

Regionalization of wastewater treatment facilities will require changes in the present institutional arrangements for sewage collection, treatment and disposal. In other areas a number of governmental and financing arrangements have achieved success in implementing regional water quality control programs in areas formerly containing fragmental patterns of local government structure and dispersed responsibilities and controls for water quality control activities. At one extreme are devices such as voluntary service contracts among public entities that do not alter the basic structure of functional responsibilities of the entities. At the other extreme are public financing and governmental mechanisms that have changed local government structure, transferred functional responsibilities among existing public entities and consolidated existing entities into new multi-purpose or single-purpose regional entities.

THE RECOMMENDED PLAN

If the beneficial use of many of the study areas's streams is to be maximized, then it is imperative that all streams not naturally ephemeral should be maintained at a flow rate that is sufficient to sustain a balanced flora and fauna. The pollution control measures described in this report will prove ineffective in restoring high levels of water quality unless minimum flows are maintained.

The analyses performed as part of this study indicate that control of point sources of pollution will significantly upgrade water quality. Major investment in non-point source controls should be deferred until the results of implementation of the provisions of the Federal Water Pollution Control Act as amended in 1972 become apparent. Thus the emphasis in the recommended plan is placed on control of point sources.

Some questions still exist as to the degree of point source control necessary to effect compliance with the Class "C" stream water quality standards. Consequently the recommended plans for municipal discharges include a step-by-step approach to improvement of waste treatment which will allow determination of the impact on water quality of a treatment improvement before a further improvement is made.

It is apparent that infiltration and inflow are excessive in many collection systems in the study area. It is recommended that measures be taken to reduce infiltration as soon as possible in order to extend the life of existing treatment facilities and reduce the volume of waste flow that must be treated at new plants.

The recommended plans for municipal wastewater management in 1980 are shown in Figure 2-2. Possible developments of the plans after 1980 are shown in Figure 2-3.

No hard-and-fast recommendations with respect to institutional arrangements for municipal wastewater treatment are made in this report. Development of the administrative structure necessary to implement the plan ultimately must be the responsibility of the local communities. Some institutional possibilities, in order of their desirability, are:

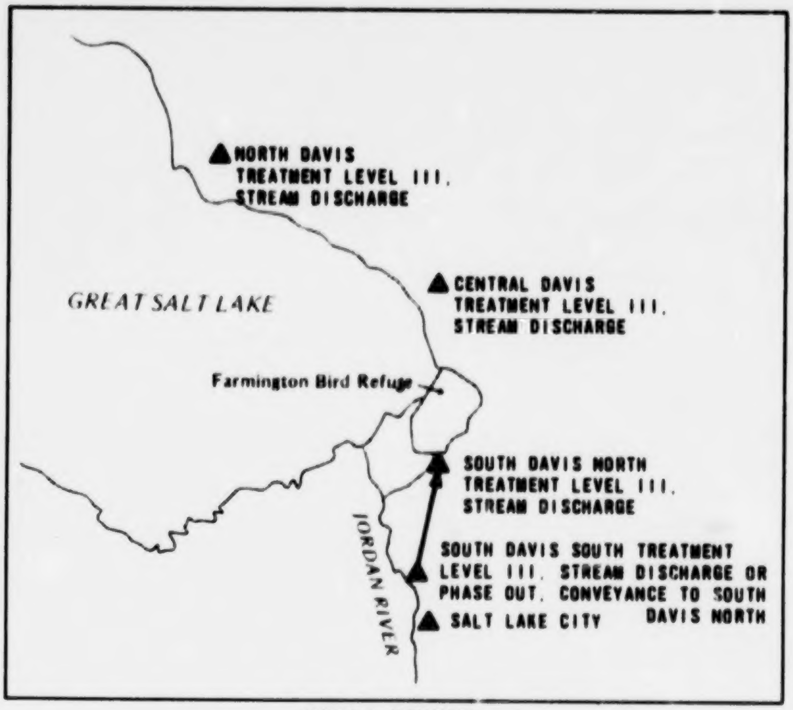
1. associations of agencies under the provisions of the Interlocal co-operation Act, 1965;
2. contractural agreements with a single lead agency.
3. formation of new regional sewerage districts.

The plan will be implemented by means of the State plan review process and the construction grants program.

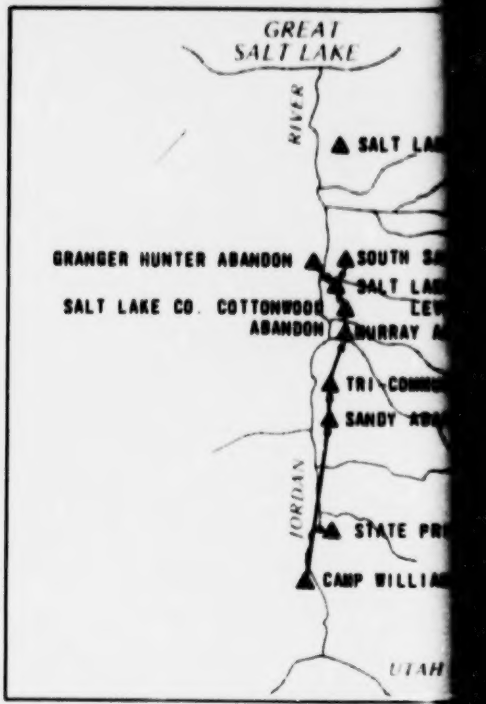
The principal mechanism by which the recommended plan will be enforced is the National Pollutant Discharge Elimination System (NPDES) or permit program presently administered by the Environmental Protection Agency.

It is recommended that the early emphasis in non-point source control be placed on changes in practices that minimize waste production. The following measures would reduce urban runoff waste emissions.

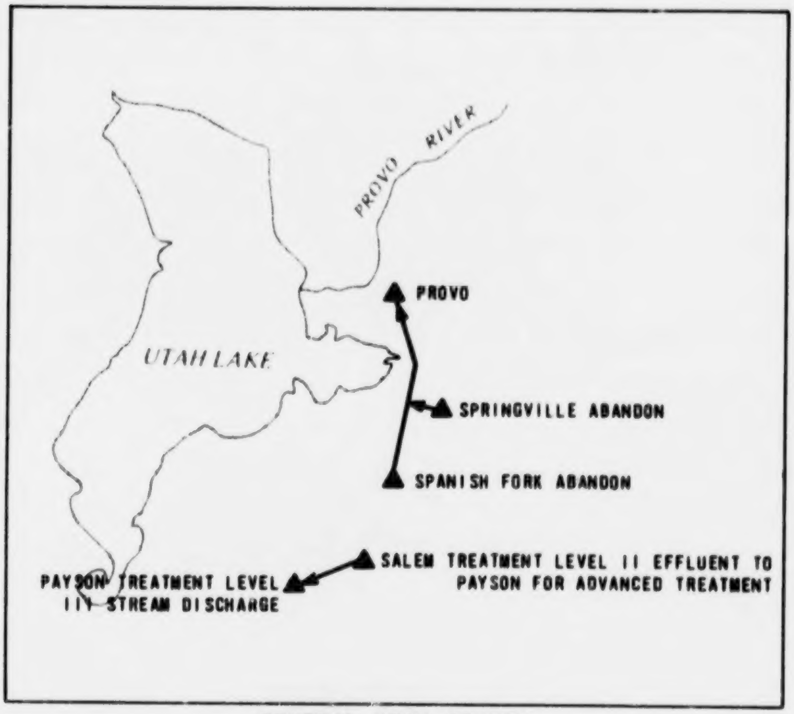
1. vigilant enforcement of anti-litter and refuse disposal laws
2. increased street-cleaning effort


NORTH DAVIS
TREATMENT LEVEL III, STREAM DISCHARGE
CENTRAL DAVIS
TREATMENT LEVEL III, STREAM DISCHARGE
GREAT SALT LAKE
Farmington Bird Refuge
SOUTH DAVIS NORTH
TREATMENT LEVEL III, STREAM DISCHARGE
JORDAN RIVER
SOUTH DAVIS SOUTH TREATMENT LEVEL III, STREAM DISCHARGE OR PHASE OUT, CONVEYANCE TO SOUTH DAVIS NORTH
SALT LAKE CITY

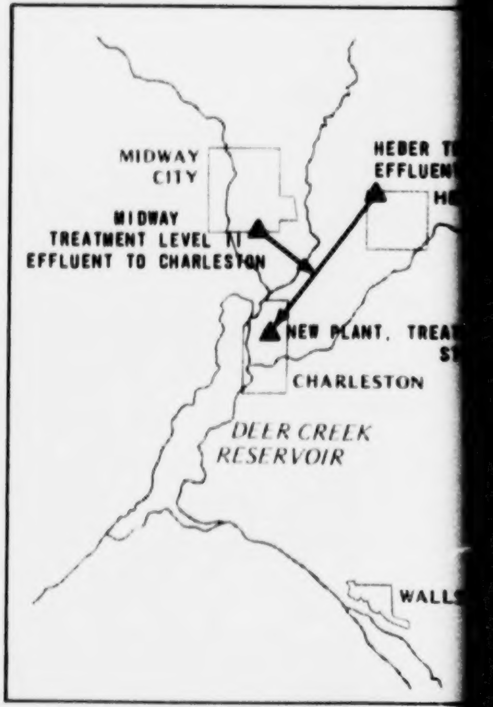
DAVIS COUNTY


GREAT SALT LAKE
RIVER
GRANGER HUNTER ABANDON
SALT LAKE CO. COTTONWOOD ABANDON
TRI-COMMU
JORDAN
UTAH

SALT LAKE CO

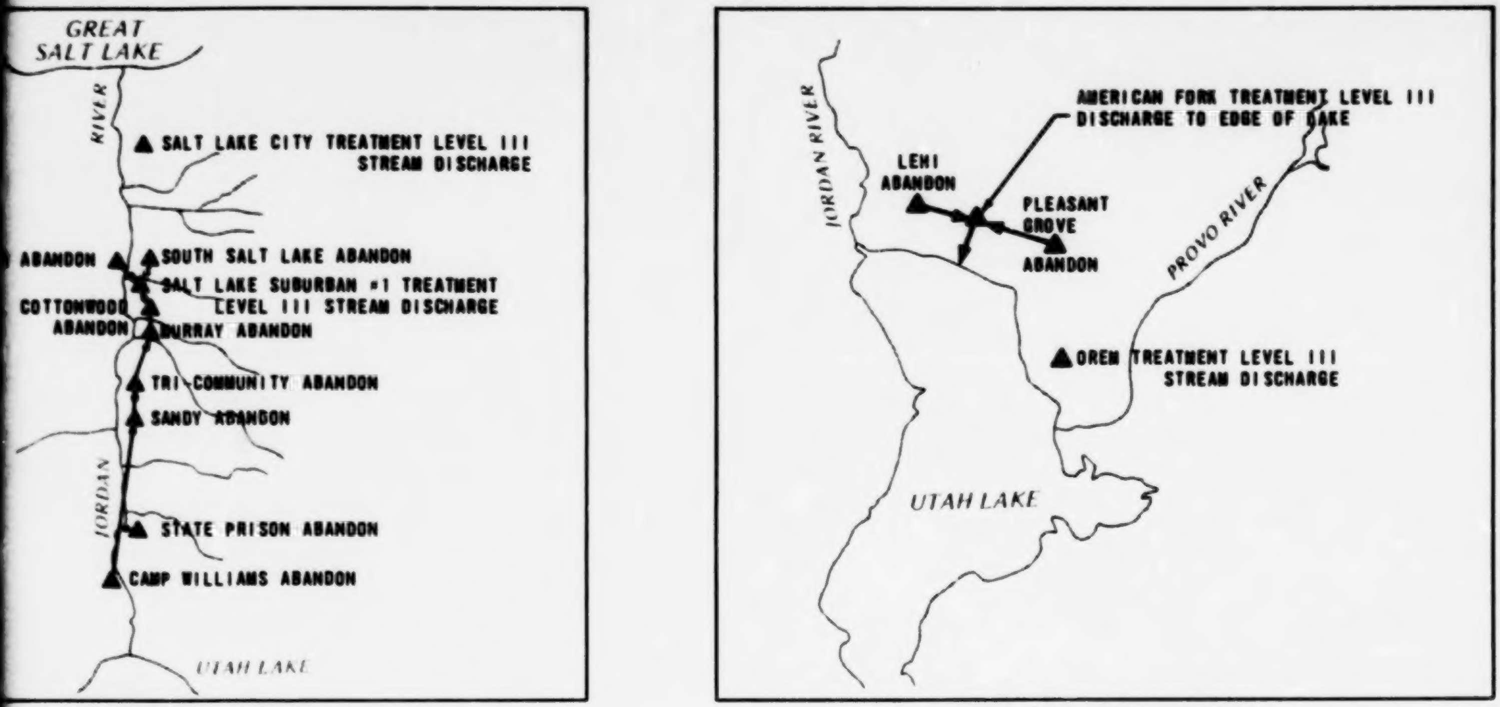

PROVO RIVER
PROVO
UTAH LAKE
SPRINGVILLE ABANDON
SPANISH FORK ABANDON
SALEM TREATMENT LEVEL II EFFLUENT TO PAYSON FOR ADVANCED TREATMENT
PAYSON TREATMENT LEVEL III STREAM DISCHARGE

CENTRAL UTAH COUNTY


MIDWAY CITY
MIDWAY TREATMENT LEVEL II EFFLUENT TO CHARLESTON
CHARLESTON
DEER CREEK RESERVOIR

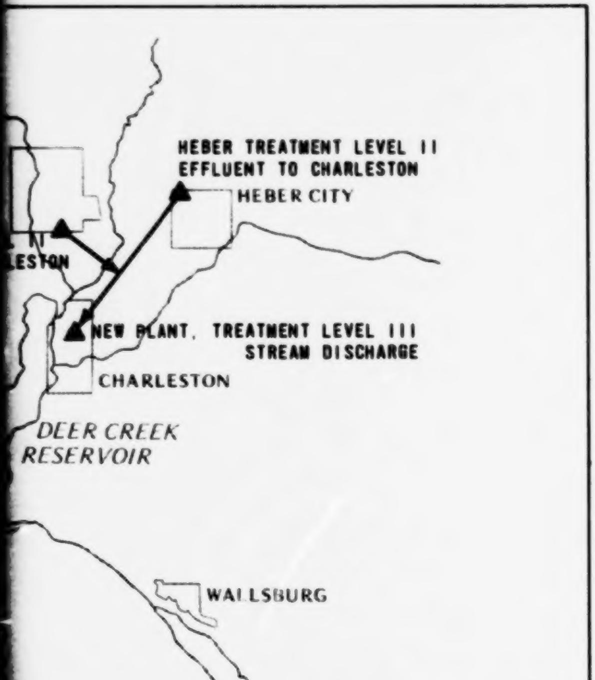
WASATCH COUN

A


GREAT SALT LAKE
RIVER
JORDAN
SALT LAKE CITY TREATMENT LEVEL III STREAM DISCHARGE
ABANDON
SOUTH SALT LAKE ABANDON
SALT LAKE SUBURBAN #1 TREATMENT LEVEL III STREAM DISCHARGE
COTTONWOOD ABANDON
MURRAY ABANDON
TRI-COMMUNITY ABANDON
SANDY ABANDON
STATE PRISON ABANDON
CAMP WILLIAMS ABANDON
UTAH LAKE
AMERICAN FORK TREATMENT LEVEL III DISCHARGE TO EDGE OF LAKE
JORDAN RIVER
LEHI ABANDON
PLEASANT GROVE ABANDON
PROVO RIVER
OREM TREATMENT LEVEL III STREAM DISCHARGE
UTAH LAKE

SALT LAKE COUNTY

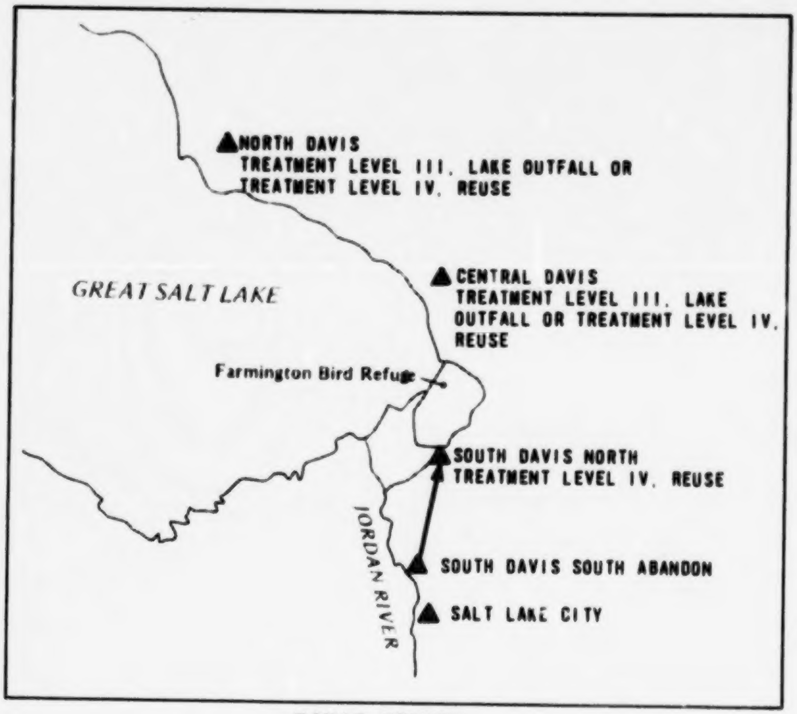
NORTHERN UTAH COUNTY


HEBER TREATMENT LEVEL II EFFLUENT TO CHARLESTON
HEBER CITY
LESTON
NEW PLANT, TREATMENT LEVEL III STREAM DISCHARGE
CHARLESTON
DEER CREEK RESERVOIR
WALLSBURG

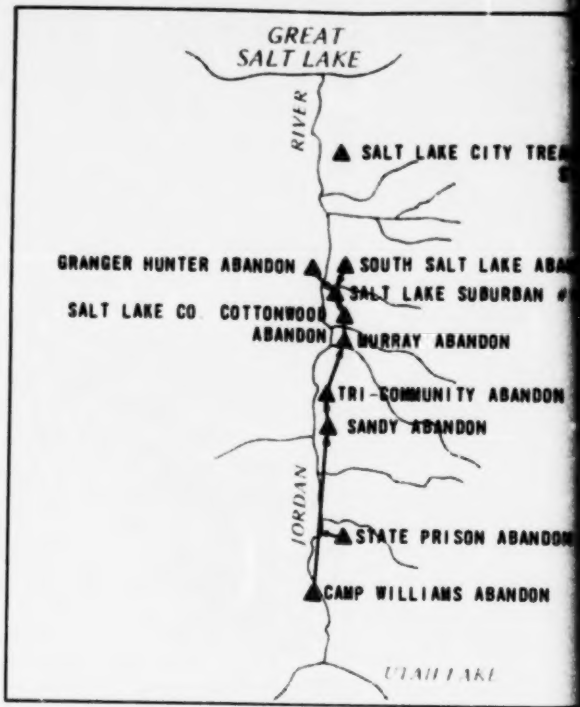
WASATCH COUNTY

FIGURE 2-2
RECOMMENDED PLANS FOR
DAVIS, SALT LAKE, NORTHERN UTAH,
CENTRAL UTAH, AND WASATCH
COUNTIES, 1980

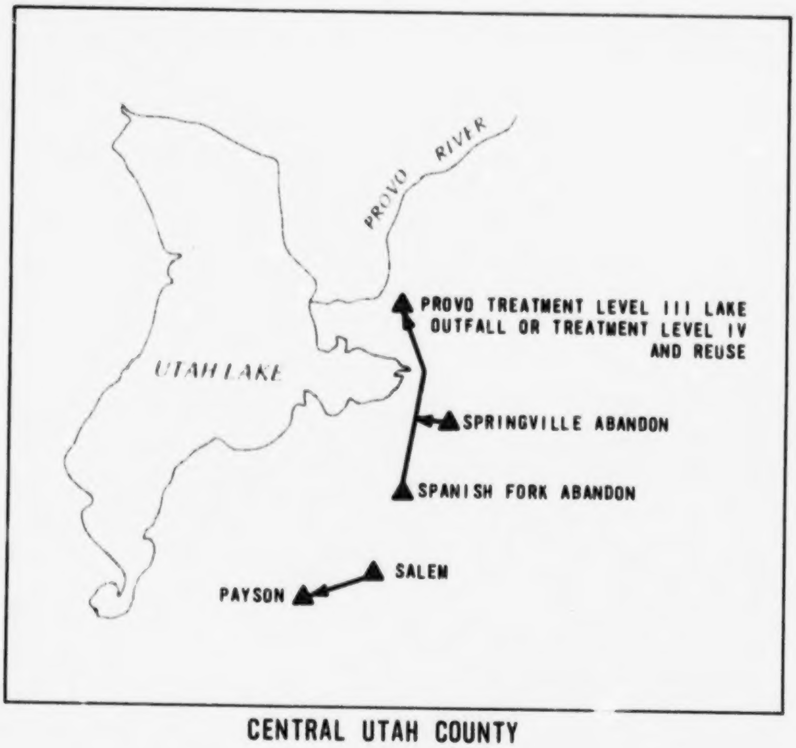
B


NORTH DAVIS
TREATMENT LEVEL III, LAKE OUTFALL OR
TREATMENT LEVEL IV, REUSE
GREAT SALT LAKE
CENTRAL DAVIS
TREATMENT LEVEL III, LAKE
OUTFALL OR TREATMENT LEVEL IV,
REUSE
Farmington Bird Refuge
SOUTH DAVIS NORTH
TREATMENT LEVEL IV, REUSE
JORDAN RIVER
SOUTH DAVIS SOUTH ABANDON
SALT LAKE CITY

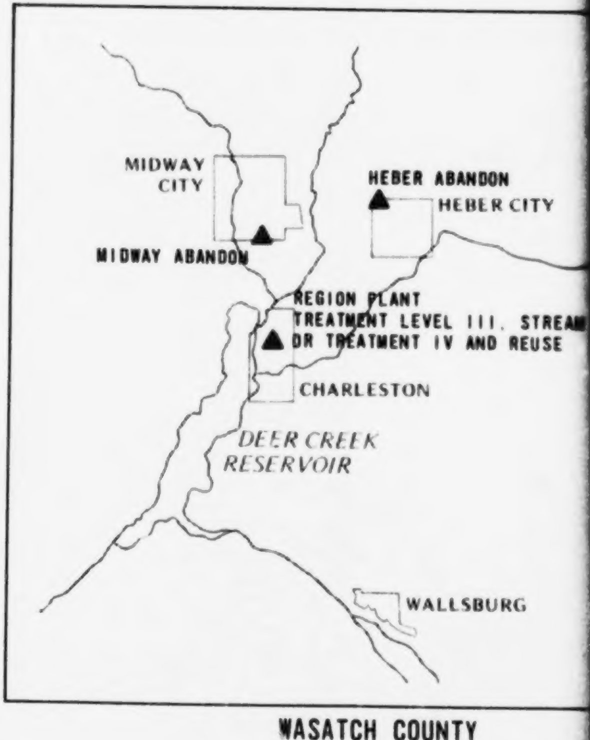
DAVIS COUNTY


GREAT
SALT LAKE
RIVER
SALT LAKE CITY TRE
GRANGER HUNTER ABANDON
SOUTH SALT LAKE ABA
SALT LAKE SUBURBAN #
SALT LAKE CO. COTTONWOOD
ABANDON
MURRAY ABANDON
TRI-COMMUNITY ABANDON
SANDY ABANDON
JORDAN
STATE PRISON ABANDON
CAMP WILLIAMS ABANDON
UTAH LAKE

SALT LAKE COUNTY

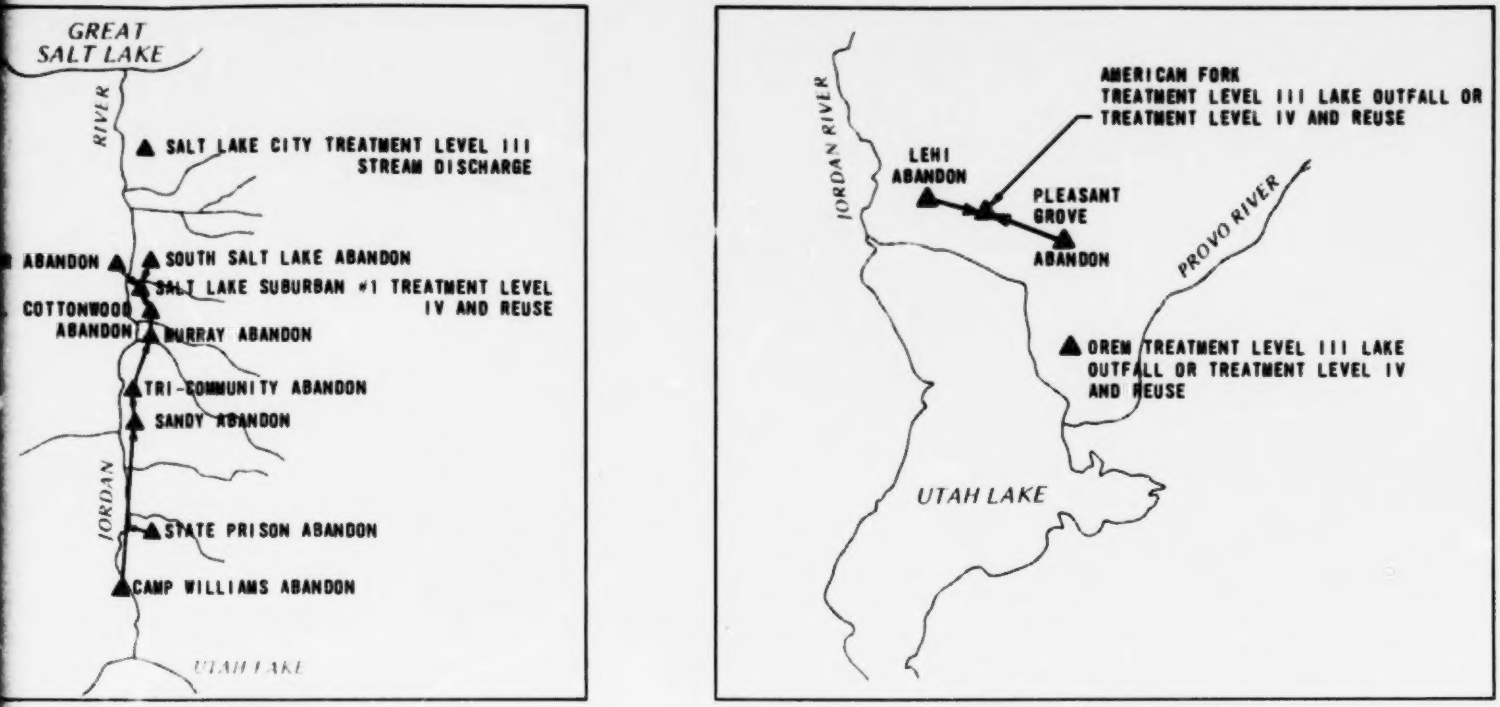

PROVO RIVER
UTAH LAKE
PROVO TREATMENT LEVEL III LAKE
OUTFALL OR TREATMENT LEVEL IV
AND REUSE
SPRINGVILLE ABANDON
SPANISH FORK ABANDON
SALEM
PAYSON

CENTRAL UTAH COUNTY


MIDWAY
CITY
HEBER ABANDON
HEBER CITY
MIDWAY ABANDON
REGION PLANT
TREATMENT LEVEL III, STREA
OR TREATMENT IV AND REUSE
CHARLESTON
DEER CREEK
RESERVOIR
WALLSBURG

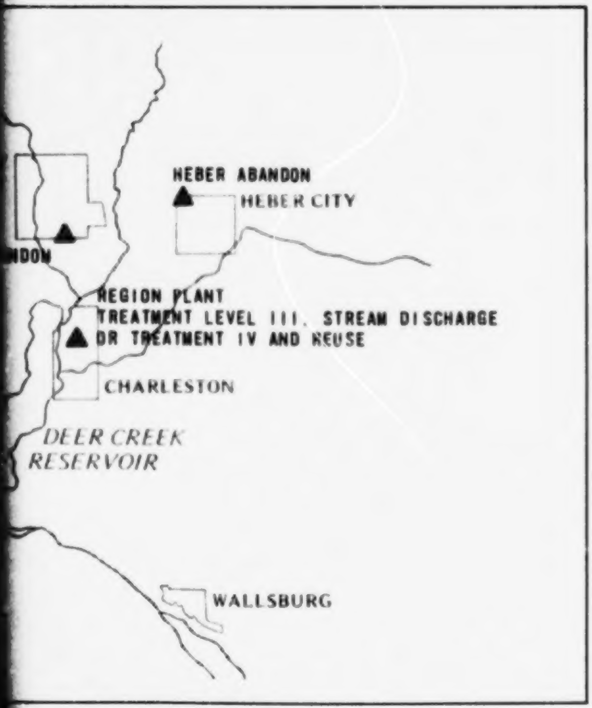
WASATCH COUNTY

A


GREAT SALT LAKE
RIVER
SALT LAKE CITY TREATMENT LEVEL III STREAM DISCHARGE
R ABANDON
SOUTH SALT LAKE ABANDON
SALT LAKE SUBURBAN #1 TREATMENT LEVEL IV AND REUSE
COTTONWOOD ABANDON
MURRAY ABANDON
TRI-COMMUNITY ABANDON
SANDY ABANDON
JORDAN
STATE PRISON ABANDON
CAMP WILLIAMS ABANDON
UTAH LAKE
JORDAN RIVER
AMERICAN FORK TREATMENT LEVEL III LAKE OUTFALL OR TREATMENT LEVEL IV AND REUSE
LEHI ABANDON
PLEASANT GROVE ABANDON
PROVO RIVER
OREM TREATMENT LEVEL III LAKE OUTFALL OR TREATMENT LEVEL IV AND REUSE
UTAH LAKE

SALT LAKE COUNTY

NORTHERN UTAH COUNTY


HEBER ABANDON
HEBER CITY
NDON
REGION PLANT TREATMENT LEVEL III, STREAM DISCHARGE OR TREATMENT IV AND REUSE
CHARLESTON
DEER CREEK RESERVOIR
WALLSBURG

WASATCH COUNTY

FIGURE 2-3
POSSIBLE DEVELOPMENT OF
RECOMMENDED PLANS FOR
DAVIS, SALT LAKE, NORTHERN UTAH,
CENTRAL UTAH, AND WASATCH
COUNTIES, 1983-1995

B

3. improved maintenance of street surfaces
4. catch-basin cleaning effort, particularly during the period just before the seasonal storms
5. education of street maintenance personnel with respect to urban runoff and water pollution
6. prevention of excessive street salting
7. prohibition of the use of storm drainage channels as a repository for snow cleared from city streets

Mitigation measures that would reduce waste loads to surface waters from non-point agricultural sources are recommended below.

Control of animal husbandry operations may be accomplished by:

1. prevention of animals from entering surface waters; where reasonably possible
2. management of surface drainage in animal confinement and manure-storage facilities to minimize generation of polluted runoff; and
3. management of lands receiving animal manure to minimize erosion and runoff.

Surface water pollution due to irrigation return flow may be minimized by the implementation of the following measures.

1. prevention of water diversions in excess of crop requirements
2. adoption of more efficient irrigation methods
3. reduction of soil erosion through better irrigation management.

CHAPTER 3

THE NATURAL ENVIRONMENT

North-central Utah is a land of dramatic contrasts: verdant alpine meadows and snow-covered mountain peaks exist only thirty miles from arid semi-desert and the largest land-locked saline lake in the western hemisphere. Intensively farmed irrigated acreage lies a short distance from mountain ski areas recognized to be among the world's finest. These contrasting land forms and uses are reflected by rapid changes in stream water quality and an unusual diversity of water quality problems. As a preface to the analysis of these problems and development of solutions, the characteristics of the natural environmental setting for the study are described in this chapter.

TOPOGRAPHY

The study area includes two major drainage basins, the Utah Lake Basin and the Salt Lake Valley. The Salt Lake Valley is bounded on the east by the Wasatch Mountains and on the west by the Oquirrh Mountains. The Utah Lake Basin is bounded on the west by the East Tintic Mountains and drains areas as far east as the western slopes of the Uinta Mountains. Streams flow westward from the Wasatch Mountains into the Jordan River and into Utah Lake, which is itself drained by the Jordan River which flows to the Great Salt Lake. No major streams rise on the western side of the basins. The transition between the valleys and the surrounding mountains is quite sharp throughout the study area. In most places the change from the relatively level valley floor to the mountain slopes occurs within a few hundred feet. Major topographical features are shown in Figure 3-1.

The Utah Lake drainage basin, which includes Heber Valley and Utah Valley is the southernmost basin of the Wasatch Front. Utah Valley slopes gradually from 4,475 feet to 5,000 feet above sea level and is surrounded on all sides by mountains. To the west are the Lake Mountains and West Mountain, with elevations of 7,500 and 8,500 feet, respectively. The 6,500 foot high Traverse Mountains are the northern boundary of the Utah Lake drainage separating it from the Salt Lake Valley and the Great Salt Lake. Utah Valley

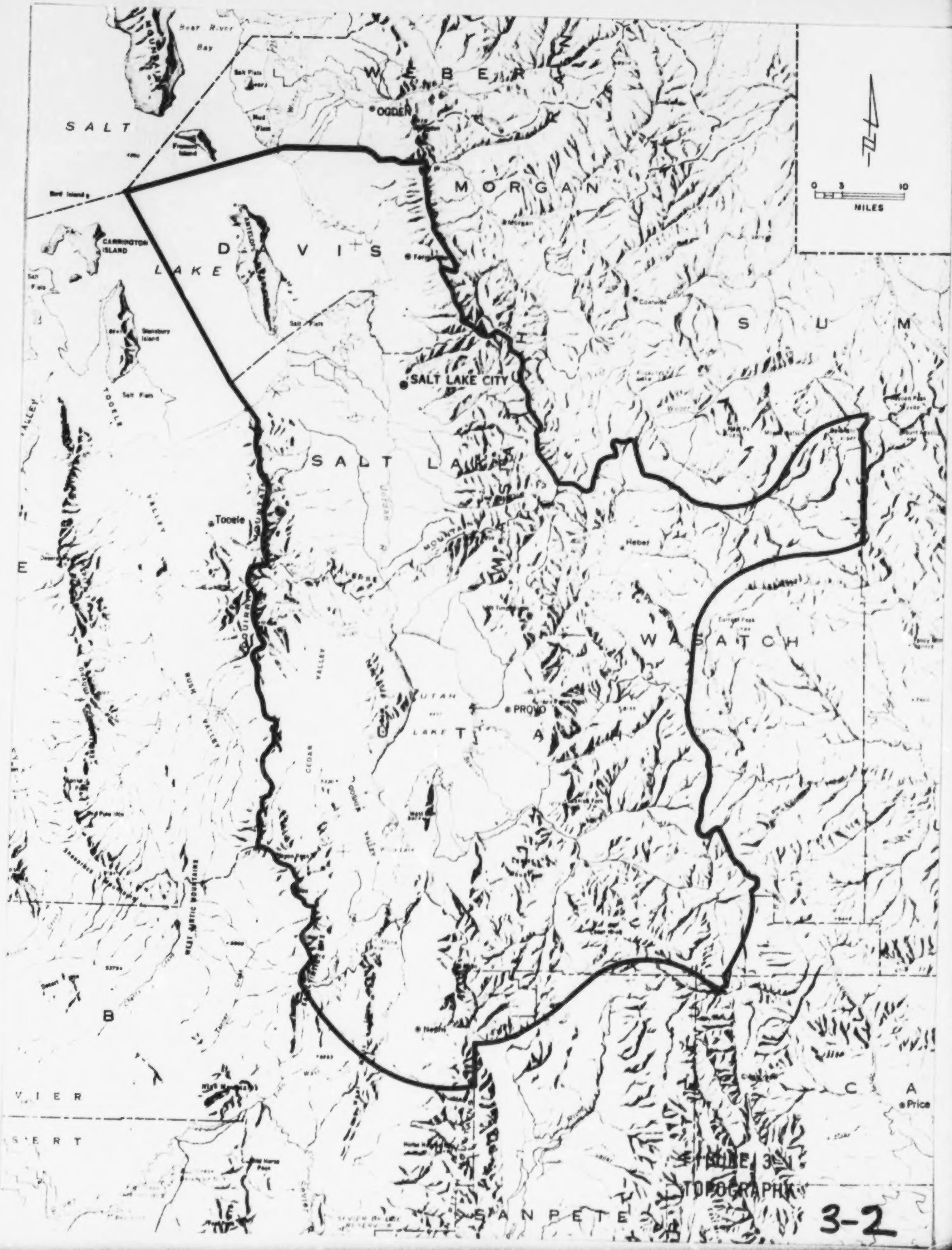

Bear River Bay
SALT
LAKE
WEBER
OGDEN
Fremont Island
Bird Island
MORGAN
Morgan
0 5 10
MILES
CARRINGTON ISLAND
Antelope
DAVIS
Salt Flats
Stansbury Island
Coalville
SUMMIT
SALT LAKE CITY
TOOELE
Tooele
SALT LAKE
Jordan
Heber
WASATCH
UTAH LAKE
PROVO
UTAH
CEDAR VALLEY
RUSH VALLEY
WEST TINTIC MOUNTAINS
Nephi
JUAB
SEVIER DESERT
SANPETE
CARBON
Price

FIGURE 3-1
TOPOGRAPHY

is about 35 miles long and 12 miles wide. Most of the western half of the valley floor is covered by Utah Lake, a shallow freshwater lake covering about 150 square miles. The Provo River and its tributaries drain generally in a southwesterly direction into Utah Lake. Other streams in the drainages south of the Provo River drainage flow in a northwesterly direction into Utah Lake.

Fifteen miles to the northeast of Utah Valley the Provo River canyon broadens out into the Heber Valley at an elevation of between 5,400 and 5,700 feet above sea level. This valley, surrounded by the Wasatch Mountains, is drained by the Provo River alone.

The Jordan River drainage, which encompasses Salt Lake County and a portion of Davis County, has an elevation of 4,200 feet above sea level at Great Salt Lake and rises 1,000 feet towards the foot of the mountains. The Salt Lake Valley is bordered on the east by the Wasatch Mountains, on the south by the Traverse Mountains, on the west by the Oquirrh Mountains and on the north by the Great Salt Lake. The Salt Lake Valley has a maximum length of about 31 miles and an approximate width of 23 miles. Roughly 68 percent of the 780-square-mile drainage area lies within the valley itself while the remaining 32 percent lies in the surrounding mountainous areas.

The land surface that extends from the foot of the Wasatch and Oquirrh Mountains toward the Jordan River consists of a series of benches, each of which slopes gradually away from the mountains and is terminated by a somewhat abrupt drop to the next bench in the series. Hence, an east-west profile across the valley would show a series of steps leading from the mountains on each side down to the Jordan River and the fertile flat valley floor. The land surface for a number of miles southeast from the shore of the Great Salt Lake is monotonous, flat and covered with alkali soil that supports little vegetation.

CLIMATE

The Utah Lake-Jordan River drainage area lies on or near several climatic boundaries. Weather of the area is influenced by its location in the eastern part of the Great Basin and is modified by its proximity to Great Salt Lake and the Wasatch Mountains. As a result, the area possesses a transitional climate which might be described as semi-continental and semi-arid.

Most precipitation in the study area is received during the winter in the form of snow. The majority of storms are of the orographic type: storms caused by moist air being forced up over a topographic barrier. The amount of precipitation varies with increases in elevation as shown in Table 3-1. Near the Great Salt Lake average annual precipitation ranges from 12 to 15 inches, while the foothills at the base of the Wasatch Mountains and Uinta Mountains to the east, the precipitation received totals 35 to 40 inches, with isolated areas in the Wasatch Mountains receiving as much as 60 inches per year (References 3-1 and 3-2).

Potential evapotranspiration rates range from 27 to 30 inches near the Great Salt Lake to less than 18 inches in the mountainous areas.

The daily temperature varies considerably. The average daily temperature varies most from June to October and least from December to February. Average monthly and annual temperatures are shown in Table 3-2. Also to be noted are the temperature variations with changes in elevation. Average annual temperatures range from about 51°F near the Great Salt Lake to about 36°F in the Wasatch Mountains.

The frost-free season varies from 143 days near the Great Salt Lake to 102 days in Heber Valley. The number of frost-free days decreases with increases in elevation throughout the study area.

Generally, the climate of the area is variable but is not extreme. The mountain ranges act as barriers normally preventing the movement of Arctic air masses from entering the valley, Except for isolated temperature inversions in valley areas during the winter, temperatures usually decrease with increase in elevation.

GEOLOGY AND SOILS

The Salt Lake and Utah Valleys are small parts of a larger area that during the glacial epoch was covered by ancient Lake Bonneville. This lake had a maximum length of 350 miles, a width of about 145 miles, and covered approximately 20,000 square miles in Northwestern Utah. The geology of the

TABLE 3-1

AVERAGE MONTHLY AND ANNUAL PRECIPITATION

(1931 - 1960)

OF SELECTED SITES IN THE

UTAH LAKE-JORDAN RIVER HYDROLOGIC BASINS

STATION	HEBER	SPANISH FORK	LEHI (UTAH LAKE)	SILVER LAKE* BRIGHTON	SALT LAKE CITY
LOCATION (County)	WASATCH	UTAH	UTAH	SALT LAKE	SALT LAKE
ELEVATION	5600	4600	4490	8740	4260
MONTHLY PRECIP. (Inches)					
January	1.82	1.78	0.84	5.98	1.80
February	1.74	1.64	0.85	2.82	1.70
March	1.36	1.95	0.91	2.50	1.35
April	1.19	1.83	0.95	5.37	1.21
May	1.11	1.45	0.92	2.39	1.12
June	1.01	1.00	0.70	2.46	1.06
July	0.76	0.73	0.62	2.65	0.78
August	1.00	0.83	0.91	4.29	0.90
September	0.74	0.76	0.46	4.94	0.76
October	1.25	1.48	0.90	0.45	1.26
November	1.39	1.58	0.78	7.89	1.39
December	1.68	1.73	0.97	12.95	1.87
TOTAL	15.05	16.79	9.82	54.69	15.20

*Precipitation values taken from 1964 - 65 Water Year.

TABLE 3-2

AVERAGE MONTHLY AND ANNUAL TEMPERATURES

(1931 - 1960)

OF SELECTED SITES IN THE

UTAH LAKE-JORDAN RIVER HYDROLOGIC BASINS

STATION	HEBER	SPANISH FORK	LEHI (UTAH LAKE)	SILVER LAKE* BRIGHTON	SALT LAKE CITY
LOCATION (County)	WASATCH	UTAH	UTAH	SALT LAKE	SALT LAKE
ELEVATION	5600	4600	4490	8740	4260
MONTHLY TEMP. (°F)					
January	21	29	26	23	29
February	25	33	31	19	33
March	34	41	39	20	40
April	44	51	48	35	50
May	52	59	56	38	60
June	59	68	65	48	67
July	67	77	72	57	75
August	66	75	71	54	72
September	58	66	61	42	65
October	48	54	50	43	53
November	34	40	36	26	38
December	26	32	29	21	32
ANNUAL	45	52	49	36	51

*Water Year - Oct, 1964 - September 1965 area was described many years ago in a classic report by Gilbert (Reference 3-3). A brief history of the events that determined the geology of the area is given as a background to the present geologic setting.

The Bonneville Basin was formed in late Tertiary time by folding and faulting that tended to reduce the relief of the region. Long after the basin came into existence the climate became more humid and lakes formed, rising to within 90 feet of an overflow point at Red Rock Pass, Idaho. After falling to a level somewhat below the level of the present Great Salt Lake, the waters rose again and overflowed at Red Rock Pass. At this level, known as the Bonneville stage, the surface stood at an altitude of 5,200 feet above sea level. Although the life of the lake at this level was short, it was long enough to allow waves and shore currents to produce characteristic shore features which are recognizable around the margin of the basins. These processes account for the previously mentioned abrupt transition from rugged mountain topography to smooth, gently sloping plains produced by the receding lake.

As the overflowing water eroded away the alluvial deposits in Red Rock Pass, the lake surface fell to 4,800 feet, a level known as the Provo stage. Although the lake remained at this level for a long period of time, the evidence of its shoreline is less striking than that for the Bonneville stage. The lowering of the lake level from the Provo stage to the present level of the Great Salt Lake took place entirely by desiccation.

The sediments of the Jordan Valley and Utah Lake Basin were derived from material deposited by Lake Bonneville and possibly from earlier lakes that may have occupied the area. Where streams entered the lake, their velocities were checked, and the coarser sediments were deposited near the lakeshore while finer sediments were carried out into the lake before being deposited. For the most part, sediments brought into the valleys by the mountain streams did not remain undisturbed but were reshaped by the action of waves and shore currents. The product of this activity is the wave-cut terraces or benches and the bars and spits that are a conspicuous feature of the present topography.

The valleys are underlain by unconsolidated deposits of clay, silt, sand and gravel several hundred feet thick. Generally, the layers of clay and silt were deposited during the several glacial periods and the gravel beds were derived from deltaic deposits of alluvium from mountain streams (Reference 3-4).

The soils within the two hydrologic basins have characteristics that were influenced both by glaciers and by ancient Lake Bonneville. Four basic soil types are found within the area.

The soils surrounding and underlying the Great Salt Lake, Jordan River and portions of Utah Lake are heavy-clay textured, poorly drained, high in organic content, low in density and are commonly high in alkali content. The water table is usually very high in these areas. The soils are generally unsuited for agriculture or urban development without special treatment.

Soils located on low lake terraces are loamy in texture and are moderately to well drained. Alkali content is generally high, but organic content is less and subsurface density is similar to adjacent soils surrounding the lake areas. A wide variety of crops is produced on these soils. Several communities comprising the major portion of the basin's population are located on these soil types.

Soils located on high lake terraces consist primarily of sand, silts and clay similar to those found on the lower terraces, together with coarser material found in the numerous alluvial fans and glacial moraines.

Soils in the mountainous areas are coarse textured and well drained and are composed of gravels and boulders resulting from extensive glacial activity, stream erosion or landslide action in many of the canyon areas. These soils are generally unsuited for tillage or development due to steep slopes or thin soil horizons.

THE SURFACE WATER SYSTEM

Approximately 480 miles of surface streams and many lakes and reservoirs lie within the basin. Stream miles by county and mean annual discharge are shown in Table 3-3. Table 3-4 is a listing of all reservoirs and lakes and their uses.

The surface water system within the basins consists of Utah Lake, a large freshwater body, fed by many streams from the east and drained by the Jordan River. The Jordan River and its tributary streams discharge to the southern portion of the Great Salt Lake.

TABLE 3-3

UTAH LAKE-JORDAN RIVER
HYDROLOGIC BASINS

STREAMS IN EACH COUNTY

STREAM	DRAINAGE AREA (SQ. MILES)	STREAM LENGTH (MILES)	MEAN ANNUAL DISCHARGE (ACRE-FT.)
Davis County			
No. Fork Kays Creek	NA	10.62	NA
So. Fork Kays Creek	NA	4.69	NA
Holmes Creek	2.49	8.64	2,690
Baer Creek	NA	7.20	NA
Farmington Creek	10.00	9.87	9,190
Ricks Creek	2.35	4.67	1,640
Parrish Creek	2.08	6.49	1,140
Centerville Creek	3.15	6.41	1,880
Stone Creek	4.48	7.57	2,330
Mill Creek	8.79	10.25	4,630
Total Davis County	32.06	76.41	23,500
Salt Lake County			
City Creek	19.1	10.0	11,730
Red Butte Creek	7.25	5.79	3,060
Emigration Creek	18.0	11.14	4,420
Parleys Creek	50.1	14.35	18.970
Mill Creek	21.7	19.97	11,150
Big Cottonwood Creek	48.5	22.35	52,879
Little Cottonwood Creek	27.4	20.13	43,903
So. Fork Dry Creek	NA	3.1	NA
Willow Creek	NA	2.1	NA
Corner Canyon	NA	2.0	NA
Jordan River	3,828	55.0	234,700
Total Salt Lake County	192.05	165.93	380,812
Utah County			
Dry Creek	10	10.02	17,970
American Fork Creek	51	15.0	37,500
Provo River	640 (total)	15.1	350,500 (total)
Spanish Fork River	670	26.2	157,800
Payson Creek	18.8	5.3	9,120
Diamond Fork Creek	490	21.2	63,560
Maple Creek	2.9	4.6	2,450
Hobble Creek	105	22.7	35,470
Total Utah County	1987.7	120.12	674,370
Wasatch County			
Provo River	39.0	52.40	
Snake Creek	NA	9.33	33,430
Pine Creek	NA	6.70	NA
Daniels Creek	NA	18.00	NA
Spring Creek	NA	4.23	NA
Lake Creek	NA	11.20	NA
Total Wasatch County	39.0	101.86	33,430
Juab County		5.0	
San Pete County			
Current Creek	NA	6.8	NA
Summit County			
Provo River	NA	3.5	NA
Total of two Hydrologic Basins (Total Jordan River drainage)	3828.	479.62	1,112,112

*Excludes Jordan River drainage area

Source: Hydrologic Atlas of Utah (Reference 3-5)

TABLE 3-4
UTAH LAKE-JORDAN RIVER
HYDROLOGIC BASINS
MAJOR LAKES AND RESERVOIRS

LAKE OR RESERVOIR	OWNERSHIP OR SURROUNDING LAND	CAPACITY AC.FT.	SURF AC.	
Salt Lake County				
Upper Bells Canyon	Wasatch Natl. Forest	175	20	Irrig., Rec.
Mountain Dell Res.	Salt Lake City	3085	- -	Municipal
Lake Florence	Wasatch Natl. Forest	72	4.8	Irrig., Rec.
Lake Lillian	Wasatch Natl. Forest	131	9.0	Irrig., Rec.
Lake Blanche	Wasatch Natl. Forest	195	12.6	Irrig., Rec.
Twin Lakes Res.	Wasatch Natl. Forest	578	21	Municipal, Rec.
White Pine Lake	Wasatch Natl. Forest	3147	12.4	Irrig., Rec.
Red Pine Lake	Wasatch Natl. Forest	975	27.4	Municipal, Rec.
Utah County				
Pittsburg Lake	Uinta Natl. Forest	60	3	Irrig., Rec.
Forest Lake	Uinta Natl. Forest	78	13	Irrig., Rec.
Silver Lake	Uinta Natl. Forest	200	10	Irrig., Rec.
Utah Lake	Private	883,900	96,000	Irrig., Rec.
Maple Lake	Uinta Natl. Forest	150	10	Irrig., Rec.
Winward Res.	Uinta Natl. Forest	100	15	Irrig., Rec.
Payson Lakes	Uinta Natl. Forest	1041	57	Irrig., Rec.
Dry Lake Res.	Uinta Natl. Forest	400	15	Irrig., Rec.
Wasatch County				
Deer Creek Res.	Private	152,570	2683	Irrigation Rec., Culin.
Mill Hollow Res.	Uinta Natl. Forest	402	17	Irrig., Rec.
Silver Lake	Private	200	10	Irrig., Rec.

TABLE 3-4 (continued)
UTAH LAKE-JORDAN RIVER
HYDROLOGIC BASINS
OTHER LAKES AND RESERVOIRS

LAKE OR RESERVOIR	OWNERSHIP OF SURROUNDING LAND	USE
Davis County		
Hobbs Res.	Private	Irrigation
Adams Res.	Private	Irrigation
Holmes Res.	Private	Irrigation
Farmington Lake	Wasatch Natl. Forest	Irrig., Rec.
Salt Lake County		
Pleasant Valley Res.	Private	Irrigation
Red Butte Res.	Wasatch Natl. Forest	
Lower Bells Canyon	Private	Irrigation
Lake Desolation	Wasatch Natl. Forest	Irrig., Rec.
Doe Lake	Wasatch Natl. Forest	Irrig., Rec.
Silver Lake	Wasatch Natl. Forest	Irrig., Rec.
Lake Mary	Wasatch Natl. Forest	Irrig., Rec.
Dog Lake	Private	Irrig., Rec.
Lake Catherine	Private	Irrig., Rec.
William Heights	Private	Irrig., Rec.
Secret Lake	Wasatch Natl. Forest	Irrig., Rec.
Lake Solitude	Private	Irrig., Rec.
Lake Martha	Private	Irrig., Rec.
Utah County		
Lake Hardy	Uinta Natl. Forest	Irrig., Rec.
Neph's Lake	Private	Irrig., Rec.
Mill Pond	Private	Irrig., Rec.
Emerald Lake	Uinta Natl. Forest	Irrig., Rec.
Hidden Lakes	Uinta Natl. Forest	Irrig., Rec.
Dry Lake	Uinta Natl. Forest	Irrig., Rec.
Tanner Res.	Uinta Natl. Forest	Irrig., Rec.
White Lake	Uinta Natl. Forest	Irrig., Rec.
Spring Lake	Uinta Natl. Forest	Irrig., Rec.
Goshen Res.	Uinta Natl. Forest	Irrig., Rec.
Salem Lake	Uinta Natl. Forest	Irrig., Rec.
Shurtz Lake	Uinta Natl. Forest	Irrig., Rec.
Stronge Lake	Uinta Natl. Forest	Irrig., Rec.
Smith's Res.	Manti Lasalle Natl. Forest	Irrig., Rec.
Red Lake	Uinta Natl. Forest	Irrig., Rec.
Lizard Lake	Uinta Natl. Forest	Irrig., Rec.
Wasatch County		
Witts Lake	Private	Irrig., Rec.
Jones Lake	Private	Irrig., Rec.
Bloods Lake	Private	Irrig., Rec.
Lackawaxen Lake	Private	Irrig., Rec.
Midway Res.	State of Utah	Irrig., Rec.
Juab County		
Mona Res.	Private	Irrig., Rec.
Summit County		
Lost Lake	Wasatch Natl. Forest	Irrig., Rec.
Washington Lake	Wasatch Natl. Forest	Irrig., Rec.
Trial Lake	Wasatch Natl. Forest	Irrig., Rec.
Crystal Lake	Wasatch Natl. Forest	Irrig., Rec.

Source: Reference 3-5 and 3-6

Utah Lake

Utah Lake, which occupies most of the western half of Utah Valley, is a shallow, freshwater lake 25 miles long and 11 miles wide with a surface area of approximately 150 square miles. In the 1860's it was historically noted that the lake was 20 feet deep, and lake trout the length of a man's arm were abundant. At the present time, through a combination of lake bed accretion and drop in water level, Utah Lake has an average depth of approximately nine feet. In addition, the type of fish inhabiting the lake has changed from trout to predominately warm water species such as the introduced carp and perch (Reference 3-7).

A prime reason for the change in characteristics of Utah Lake has been the development of agriculture in the surrounding lands. Diversion of water from tributary streams for irrigation of cropland has both reduced the quantity and degraded the quality of influent water. The greatest changes in volume and water chemistry occurred in the two decades before 1900. In 1884, when the first dam was built on the Jordan River, the total dissolved solids content of Utah Lake water was reported to be 306 mg/l with 17.8 mg/l of sodium and 12.4 mg/l chloride in the influent tributaries, although doubts exist with regard to the accuracy of the measurements. Now, as then, the major sources of sodium, chloride and sulfate ions are from the mineral springs that issue from a fault zone that runs from Saratoga on the northwest shore to Lincoln Point on the south and southerly along the east shore of Goshen Bay. By 1899, the total dissolved solids increased to 892 mg/l with 234 mg/l of sodium and 316.8 mg/l of chloride. One reason for this increase in salts was a five-foot decrease in water surface elevation;however, a substantial portion of the increased total dissolved solids, perhaps 200-300 mg/l, is attributable to upstream and nearshore land uses. Since 1900, salt content of the lake has remained fairly constant. During years of high lake levels, the water contains less salt per volume, while in low-water years the reverse is true.

For many years Utah Lake has been operated as a water supply reservoir for irrigated croplands in the Salt Lake Valley, a purpose for which it is ill-suited due to its shallowness and large surface area. Approximately half of the annual inflow to the lake evaporates leading to a doubling of the salt content within the lake, and to high levels of dissolved solids in the Jordan River as compared to Utah Lake tributaries. Flow from the lake into the Jordan River is regulated, year round. At low lake stages, water is pumped out of the lake and into the river.

Utah Lake Tributaries

Utah Lake is fed by two large rivers, the Provo River and Spanish Fork, and several smaller streams. The natural inflow to the valley approximates 500,000 acre-feet per year, half of which occurs during April, May and June, a period of low irrigation needs (Reference 3-8). Utah Lake tributaries are shown in Figure 3-2.

Early irrigators accepted these flows as they occurred; however, as water demand increased, engineering works were undertaken to transfer water from other basins. Currently four large interbasin transfers deliver an average of almost 150,000 acre-feet to the Utah Valley's supply, while a fifth subtracts about 25,000 acre-feet annually. The Ontario Tunnel diverts approximately 10,000 acre-feet/year of Silver Creek water to the upper reaches of the Provo River. This is supplemented by approximately 30,000 acre-feet/year from the Duchesne River and 50,000 acre-feet/year from the Weber-Provo Canal. Approximately 70,000 acre-feet/year are diverted from Strawberry Reservoir to Diamond Fork, a tributary of Spanish Fork (Reference 3-6).

Approximately half of the water that enters Utah Valley is supplied via Provo River. The headwaters of the Provo are located in the western part of the Uinta Mountains about 45 miles northeast of Provo. The Provo flows westward from the high mountain streams and lakes through the Kamas Valley and south into the lower Heber Valley where it is dammed, forming Deer Creek Reservoir. Below the dam, the river flows southwestward, crossing the Wasatch Mountains through Provo Canyon to enter Utah Lake west of the City of Provo.

The Spanish Fork Basin, the second largest source of water entering Utah Lake, lies southeast of Utah Valley. The Spanish Fork rises on the Wasatch Plateau, west of Soldier Summit, about thirty miles southeast of the City of Spanish Fork, and flows northwest to its confluence with Thistle Creek at Thistle. Continuing northwestward, the river traverses

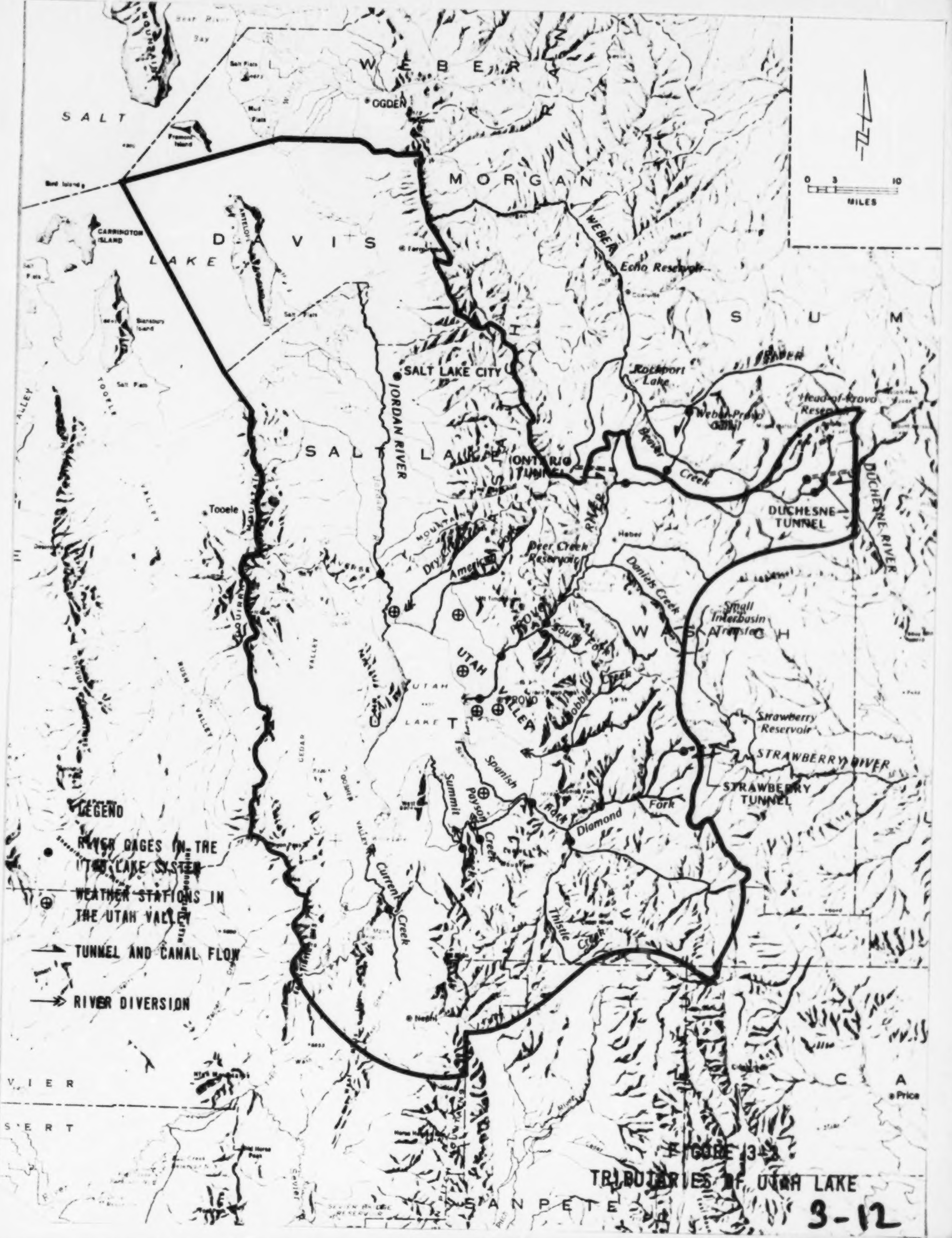

WEBER
OGDEN
SALT
LAKE
MORGAN
DAVIS
SUM
SALT LAKE CITY
JORDAN RIVER
SALT LAKE
ONTARIO TUNNEL
Tooele
Echo Reservoir
Rockport Lake
Weber-Provo Canal
Head-of-Provo Reservoir
Provo Creek
DUCHESNE TUNNEL
DUCHESNE RIVER
PROVO RIVER
Deer Creek Reservoir
Dry Creek
American Fork
Daniels Creek
Small Interbasin Transfer
WASATCH
UTAH
UTAH LAKE
PROVO
South Fork
Hobble Creek
Strawberry Reservoir
STRAWBERRY RIVER
STRAWBERRY TUNNEL
Spanish Fork
Diamond Fork
Summit Creek
Payson Creek
Current Creek
Thistle Creek
Nephi
CA
Price
VIER
SERT
SANPETE
MILES
0
5
10
LEGEND
RIVER GAGES IN THE UTAH LAKE SYSTEM
WEATHER STATIONS IN THE UTAH VALLEY
TUNNEL AND CANAL FLOW
RIVER DIVERSION

FIGURE 3-2

TRIBUTARIES OF UTAH LAKE

the Wasatch Range through Spanish Fork Canyon, entering Utah Lake four miles northwest of the City of Spanish Fork.

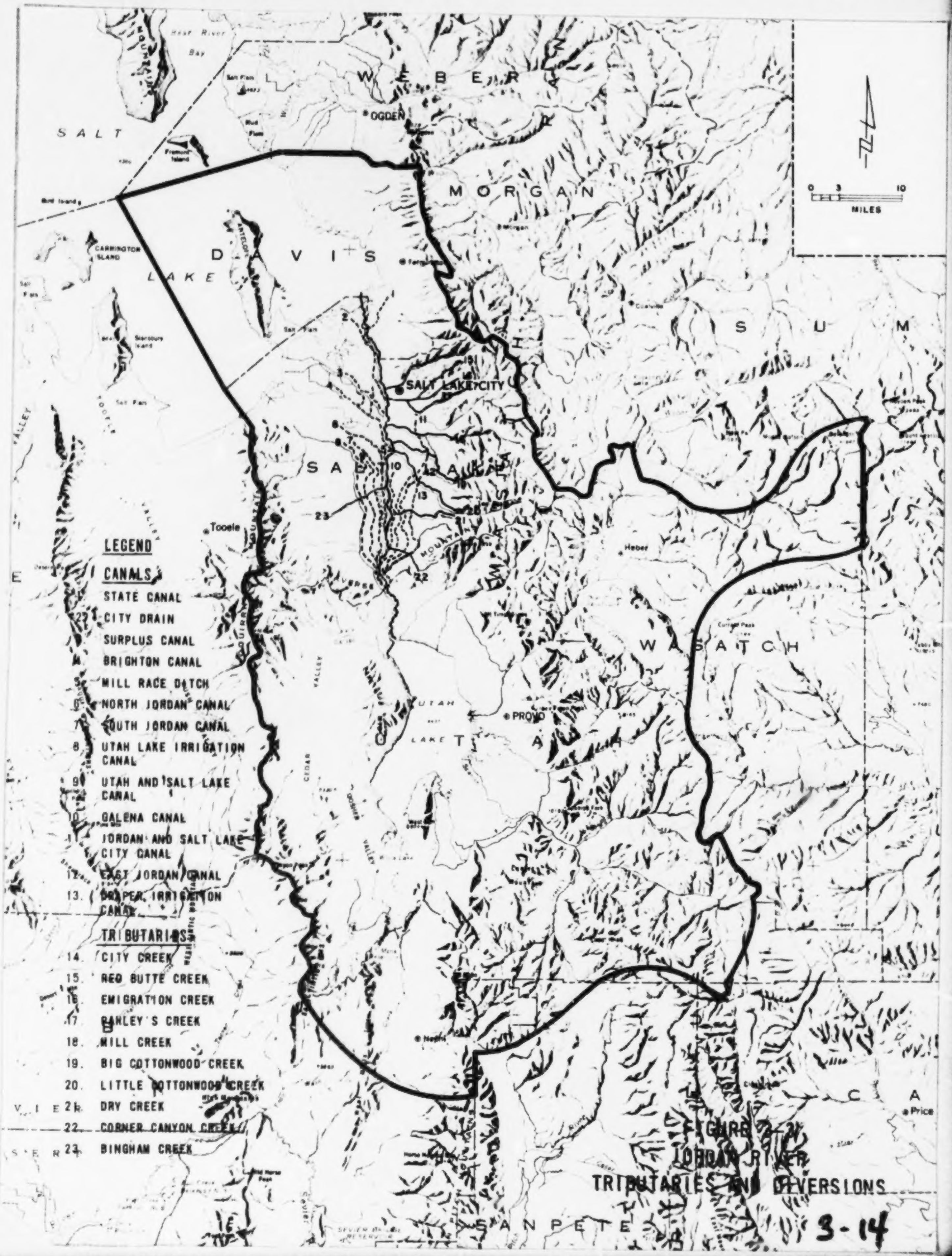
The Jordan River and Tributaries

The Jordan River begins at Utah Lake and meanders approximately 55 river miles northward to the Great Salt Lake. The river gradient is slight, averaging only 5.2 feet per mile, and flows are consequently slow moving. River flows are supplemented by many tributaries entering the river from the east and are depleted during the summer by diversions into irrigation canals, as shown in Figure 3-3. Throughout most of its length the river gains from groundwaters entering from springs and seeps and from agricultural irrigation return flows.

Water enters the Jordan River from Utah Lake through a flow-control structure. At the Jordan Narrows, where the river cuts through the Traverse Mountains 10 miles north of Utah Lake, the bulk of the river flow is diverted into irrigation canals. Flow immediately below the diversion varies from 1,400 cfs during the spring runoff to zero during the growing season. North of the diversion the river meanders through a broad flood plain, gaining flow from the groundwater, irrigation return flows, several minor wastewater treatment plants, Corner Canyon Creek and Dry Creek. Southwest of Murray, the river passes through several areas of marshland (Reference 3-9).

North of Bennion the flood plain broadens and the course of the river becomes even more tortuous. The ten-mile reach of the river north of this point passes through the Salt Lake City metropolitan area and is the recipient of many municipal and industrial waste discharges. At 21st South Street, the bulk of the river flow is again diverted, this time into the Surplus Canal. The purpose of the Surplus Canal is to provide a short, direct route to the Great Salt Lake for Jordan River flows in excess of those that can pass down the natural river channel without flooding. North of Salt Lake City the river flows through wide expanses of salt marsh to reach the Great Salt Lake approximately seven miles northwest of the city limit.

Along the course of the Jordan River a number of tributaries enter from the east side. The tributaries are similar in that they rise high in the Wasatch Mountains and flow swiftly through steep, glaciated canyons,


Bear River Bay
W E B E R
OGDEN
SALT
Fremont Island
Bird Island
M O R G A N
Morgan
0 3 10
MILES
D A V I S
Antelope Island
Carrington Island
L A K E
Stansbury Island
Salt Flats
Farmington
Coalville
S U M
SALT LAKE CITY
S A L T L A K E
Tooele
Heber
W A S A T C H
UTAH LAKE
PROVO
U T A H
Nephi
C A
Price
S A N P E T E
1
2
3
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23

LEGEND

CANALS

1. STATE CANAL
2. CITY DRAIN
3. SURPLUS CANAL
4. BRIGHTON CANAL
5. MILL RACE DITCH
6. NORTH JORDAN CANAL
7. SOUTH JORDAN CANAL
8. UTAH LAKE IRRIGATION CANAL
9. UTAH AND SALT LAKE CANAL
10. GALENA CANAL
11. JORDAN AND SALT LAKE CITY CANAL
12. EAST JORDAN CANAL
13. DRAPER IRRIGATION CANAL

TRIBUTARIES

14. CITY CREEK
15. RED BUTTE CREEK
16. EMIGRATION CREEK
17. PARLEY'S CREEK
18. MILL CREEK
19. BIG COTTONWOOD CREEK
20. LITTLE COTTONWOOD CREEK
21. DRY CREEK
22. CORNER CANYON CREEK
23. BINGHAM CREEK

FIGURE 3-2
JORDAN RIVER
TRIBUTARIES AND DIVERSIONS

finally changing their nature to slow, winding creeks as they merge with the Jordan River on the valley floor.

The Great Salt Lake

The Great Salt Lake, a remnant of ancient Lake Bonneville, is the final repository for the waters of the Utah Lake/Jordan River Basins. The lake is a large, shallow and highly saline, closed water body which gains water mainly from stream flow from the mountains to the east and loses water by evaporation. It is the largest lake in the Western Hemisphere that does not drain to the ocean. In 1965, at a lake surface elevation of 4,194 feet, the surface area was about 1,000 square miles and the maximum measured depth was 27 feet.

The Great Salt Lake changes volume continuously in response to the difference between the volume of inflow and evaporation losses. The total load of salt in the lake is relatively constant; however, salt concentration obviously changes with changes in lake volume. Salt content during the last 50 years has generally remained within the range of 250 to 350 grams/litre (Reference 3-11 and 3-12).

During 1957 and 1959, the Southern Pacific Company constructed a railroad causeway across the lake between Promontory Point and Lakeside, a distance of about 18 miles. This causeway has had a considerable impact on water quality, since it restricts circulation between the northern and southern parts of the lake. Major quantities of fresh water enter the southern part of the lake, and consequently the last decade has seen declining salt concentrations in the southern part of the lake and increasing concentrations in the north (Reference 3-13).

Beneficial uses of the Great Salt Lake include tourism, air and sail boating, and mineral extraction. Farmington Bay, a freshwater body like off from the Great Salt Lake is an extensive waterfowl habitat and hunting area. Although many people visit the lake each year, its role as a resort area has declined mainly because of the difficulties associated with a fluctuating water level. The lake's vast mineral wealth has yet to be fully developed although some minerals, including magnesium and potash are already extracted. Controversy surrounds plans for further development of the lake's mineral potential because the probable impact of industrial activity on lake ecology remains largely unknown (Reference 3-14).

Three major rivers discharge into Great Salt Lake: the Bear River, the Weber River and the Jordan River. The Jordan River drainage system is the second largest contributor of dissolved solids, and the third largest contributor of water, to the lake. Major contributors of water from the drainage system are the Jordan River, the Surplus Canal and Kennecott Drain (C7 Ditch).

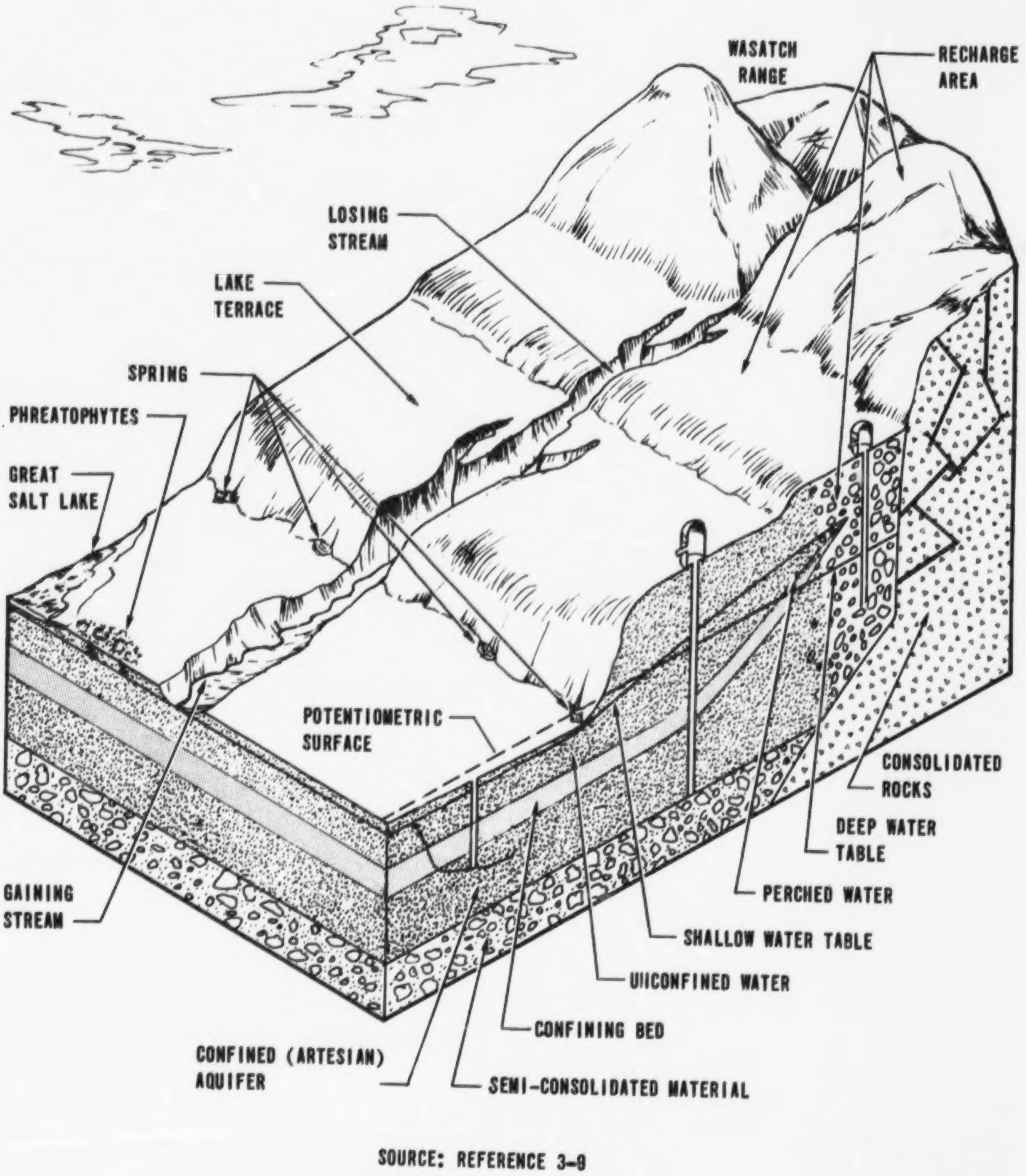
GROUNDWATER

Although the objectives of this study emphasize management of surface water quality, it is apparent that the many natural and man-made interchanges between the surface waters and the groundwater reservoir make it essential that both surface and groundwater resources and their relationship be characterized as part of the study.

The water-bearing zones or groundwater reservoirs within the study area are located principally within the unconsolidated sediments that fill much of the Salt Lake and Utah Valleys. The natural surface and subsurface flow constriction imposed by the Traverse Mountains makes it appropriate to consider the Salt Lake Valley and Utah Lake groundwater basins separately.

Salt Lake Valley

Groundwater in the Salt Lake Valley occurs in three general locations: a shallow groundwater body overlying the confining layer that creates the artesian basin, local perched water bodies and an artesian water body below the confining layer and its recharge area. The total quantity of groundwater in the Salt Lake Valley is estimated at 60 million acre-feet. A schematic cross-section of groundwater conditions in the Salt Lake Valley is shown in Figure 3-4. The extent of the groundwater bodies and their direction of flow are shown in Figure 3-5. The shallow, unconfined aquifer and the confined artesian aquifer underlie most of the Salt Lake Valley. The deep, unconfined aquifer, through which the artesian water body is recharged, exists along the valley sides at the foot of the Wasatch and Oquirrh Mountains. Perched water bodies exist east of Midvale and between Herriman and Riverton. The direction of groundwater flow in the valley is toward the Jordan River and the Great Salt Lake (Reference 3-15).


WASATCH RANGE
RECHARGE AREA
LOSING STREAM
LAKE TERRACE
SPRING
PHREATOPHYTES
GREAT SALT LAKE
POTENTIOMETRIC SURFACE
CONSOLIDATED ROCKS
DEEP WATER TABLE
PERCHED WATER
GAINING STREAM
SHALLOW WATER TABLE
UNCONFINED WATER
CONFINING BED
CONFINED (ARTESIAN) AQUIFER
SEMI-CONSOLIDATED MATERIAL

SOURCE: REFERENCE 3-9

FIGURE 3-4, SCHEMATIC OF GROUNDWATER CONDITIONS IN THE SALT LAKE VALLEY

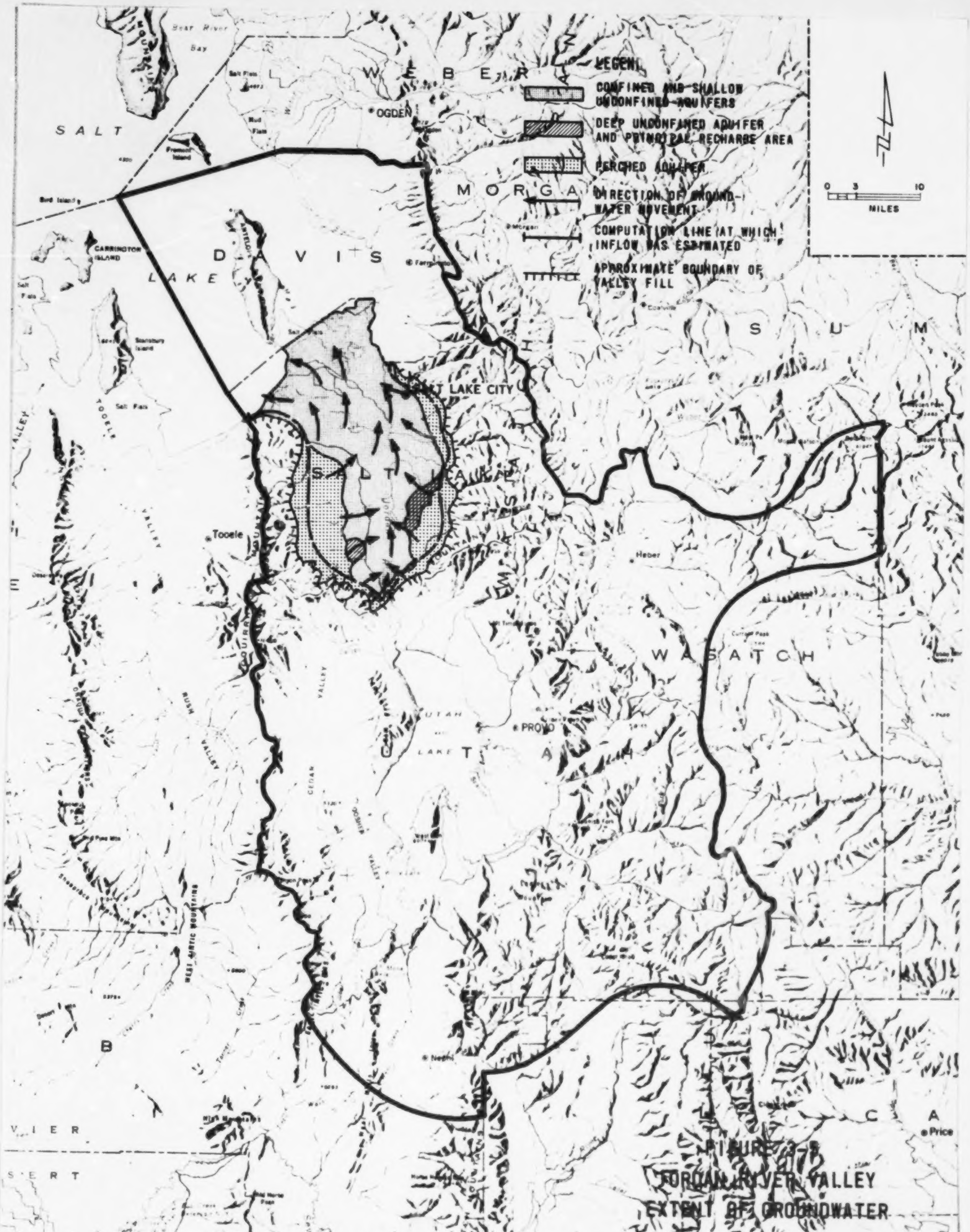

LEGEND
CONFINED AND SHALLOW UNCONFINED AQUIFERS
DEEP UNCONFINED AQUIFER AND PRINCIPAL RECHARGE AREA
PERCHED AQUIFER
DIRECTION OF GROUND-WATER MOVEMENT
COMPUTATION LINE AT WHICH INFLOW WAS ESTIMATED
APPROXIMATE BOUNDARY OF VALLEY FILL
N
0 3 10
MILES
Bear River Bay
SALT LAKE
WEBER
OGDEN
MORGAN
DAVIS
Fremont Island
Bird Island
Carrington Island
Stansbury Island
Antelope Island
SALT LAKE CITY
SALT LAKE
SUMMIT
WASATCH
Heber
Tooele
TOOELE
UTAH
PROVO
UTAH LAKE
CEDAR VALLEY
Nephi
SANPETE
SEVIER
JUAB
CARBON
Price
DESERT

FIGURE 3-5
JORDAN RIVER VALLEY
EXTENT OF GROUNDWATER

3-18

The principal source of groundwater withdrawn from wells is the confined artesian aquifer and the associated deep unconfined aquifer through which it is recharged. Although some water is withdrawn from the shallow unconfined aquifer and the perched water bodies, its use is limited to agricultural irrigation and livestock watering. In 1970 total withdrawal of groundwater from wells was estimated to be 115,400 acre-feet and was used for industrial and municipal water supply, agricultural irrigation and livestock watering.

Groundwater levels in the Salt Lake Valley have remained fairly constant during the last 50 years, suggesting that the rates of withdrawal from and recharge to, the groundwater bodies are approximately equal. The nature of these inputs and withdrawals to the groundwater reservoir, particularly where they involve an interchange between the surface and groundwater subsystems, is of considerable importance from the point of view of water quality management. This is particularly true in the case of the Salt Lake Valley, since the entire length of the Jordan River is a gaining stream, its flow augmented by groundwater seepage.

Recharge to the Salt Lake Valley groundwater reservoir comes from at least seven sources: seepage from irrigated lands, seepage from precipitation, seepage from creek channels in the foothills, subsurface bedrock springs, under flow from mountain canyons, under flow from Utah Valley through the Jordan Narrows and seepage from irrigation canals (Reference 3-16). The proportion of water from each recharge source is not known; however, seepages from irrigated lands and creek channels are probably the largest sources of recharge water.

Almost all the average annual flow of 267,000 acre-feet of the Jordan River at the Jordan Narrows is diverted for irrigation. It is estimated that approximately 45 percent of the applied water is consumptively used, the remainder returning either to the river via surface drainage or by percolating into the groundwater basin.

Many of the streams on both sides of the Salt Lake Valley lose water to the groundwater reservoir as they pass through the foothills. Estimates made of recharge quantities from the losing reaches of the two Cottonwood Creeks are of the order of 23,000 acre-feet annually.

Groundwater is discharged in the Salt Lake Valley by evapotranspiration, nonthermal springs and seeps, thermal springs, wells and drains. Springs and seeps that flow into the Jordan River and its tributaries account for about two-thirds of the 300,000 acre-feet of measurable annual discharge of groundwater (Reference 3-17). The remaining measurable discharge is withdrawn from wells.

Utah Valley

The valley fill in Utah Valley includes four main aquifers: a water table aquifer and three artesian aquifers. The municipal water needs of the valley are satisfied by groundwaters discharged from the artesian aquifers through springs and wells. Other routes for discharge from the groundwater reservoir are seepage into waterways, agricultural drains and municipal sewers, evapotranspiration and discharge into Utah Lake.

Recharge to the groundwater reservoir occurs by seepage from waterways and irrigated land, infiltration of precipitation and subsurface inflow from the surrounding mountains. Examination of water-level records indicates that long-term discharge and recharge are in equilibrium in the southern Utah Valley, while water is being mined in both Goshen Valley and northern Utah Valley (Reference 3-18 and 3-19).

FLORA AND FAUNA

Aquatic Life and Wildfowl

The waters of the Great Salt Lake are too saline to support abundant life. Only 11 species of bacteria and four species of algae grow and reproduce in the main body of the lake. Three other algal species can be found in Bear River Bay and East Bay where the water is shallow and the salt content reduced. The only fauna in the lake are protozoa and the brine shrimp Artemia salina. The brine flies Ephydra cinerea and Ephydra hians are also present in open water and near shore, respectively. Islands of the lake provide retreats for the eared grebe, white pelican, double-crested cormorant, shoveler, Northern phalarope, jaeger and several species of gull (Reference 3-20).

Utah Lake is a principal foraging area for the Great Salt Lake birds. The marshlike vegetation fringing the freshwater lake provides both food and cover. Rock Island in Utah Lake also provides suitable nesting areas and more nesting materials for waterfowl than Great Salt Lake. The Canada goose, cinnamon teal, killdeer, spotted sandpiper, sanderling, avocet, black tern, Caspian tern, forster tern and California gull can be found on the island (Reference 3-21).

Several representatives of the 55 species of algae supported by Utah Lake are found attached to rocks near the island (Reference 3-22). Others may appear as algal blooms in late summer. The algae and the pondweeds provide food and cover for several species of fish.

Early pioneers in Utah generally found the same species of fish in the valleys as in the mountains. W. F. Sigler (Reference 3-23) points out that ecological evidence exists that suggests the original native fish were the Utah chub, Utah sucker, mountain sucker, mountain whitefish, several species of minnows and the now extinct Utah cutthroat. Typical valley fish now include carp, green sunfish, largemouth bass, black bullhead, channel catfish and bluegill. Mountain populations include rainbow trout, brown trout, brook trout and limited lake trout. The Utah State Division of Wildlife Resources reports at least 49 species of fish in Utah of which 23 were established in the state through introduction. The most notable successes have been carp, rainbow trout, and brown trout. In limited areas, lake trout, brook trout and arctic grayling have become established. The channel catfish, along with the largemouth bass at one time were also harvested by commercial fishery in Utah Lake. At the present time, little commercial harvesting of sport fish exists in Utah. Utah Lake tributaries are annually stocked with rainbow trout and to a lesser extent brown trout, brook trout, lake trout and kokanne salmon. Utah Lake is stocked with warm water fish such as walleye pike and white bass. The U. S. Fish and Wildlife Fish Hatchery at Springville, Utah stocks small amounts of trout, largemouth bass, bluegill and occasionally black crappie.

Fish found in the Jordan River include the redside shiner, black bullhead, Utah sucker, mountain sucker and brown trout, as well as several Utah Lake species. There are a few stocked fish in the shallower streams and creeks which drain west from the Wasatch Mountains to Utah Lake. The benthos of the small creeks includes black flies, mayflies, caddis flies, stoneflies, craneflies, midges, beetles, nematodes and oligochetes. Hydroids, sponges, limpets, snails, leeches and aquatic moths and sowbugs make up the Jordan River benthos in addition to the species found in the smaller creeks (Reference 3-24).

Terrestrial Ecology

The major biotic communities of the Great Salt Lake Desert include marsh, juniper, mixed brush, greasewood, shadscale and vegetated dune communities. The mammals of the desert are common to each habitat. The larger mammals include the mule deer, coyote, bobcat, badger and feral cat. Smaller mammals dominate the desert communities. These include the black-tailed jack rabbit, desert Audubon cottontail, several species of ground squirrel, the white-footed deer mouse and the kangaroo rat.

Most of the birds found in the Salt Desert are confined to the shadscale and greasewood habitats. Among these birds are the turkey vulture, Rufous hummingbird, horned lark, common crow and several hawk species. The mourning dove and plain titmouse favor the mixed brush community. Most of the desert birds range into the valley grasslands and montane forests as well; only the red-shouldered hawk and the burrowing owl are confined to the Salt Desert itself (Reference 3-25).

The valley grasslands, due to early settling have mostly been converted to irrigation and agriculture. Wild inhabitants have been supplanted by introduced and domestic species. Pheasant and mourning doves abide in large numbers, while smaller populations of chukar partridge, sage and forest grouse, quail and wild turkey are found ranging into the uplands (Reference 3-26). Representative animal communities are presented in Figure 3-6.

Rising from the valley floor, the Wasatch Mountains cover the eastern part of the Utah Lake/Jordan River area and serve as the main watershed to the stream and river systems important to water supply.

Mt. Timpanogos forms a part of the Wasatch Range lying six miles east of Utah Lake in Utah County. It is bounded to the north by American Fork Canyon and to the south by the Provo River. The mountain is representative of the Wasatch Range as a whole, and many of its animals are common to the adjoining Utah Valley. The major biotic communities of the area are the lower montane forest and the upper montane forest, according to dominant plants, a few birds and certain climatic differences. (Reference 3-27).

The climax community in the lower montane forest may be technically designated as the Pinus ponderosa - Pseudotsuga mucronata - Abies concolor Association (Yellow Pine - Douglas Fir - White Fir Association). Two subclimaxes occur within the montane region and are noted as the Aspen Subclimax (Populas tremuloides) and the Uinta Mountains Lower Montane Forest which consists largely of lodgepole pine (Pinus Murrayana) and the yellow pine.

The upper montane forest is primarily dominated by the Picea englemanni - Abies lasiocarpa Association (Englemann Spruce - Alpine Fir Association). This spruce-fir association is limited to the higher elevations and covers only small portions of the study area watershed. A biotic cross-section is shown in Figure 3-7.

The major animal influents are the Rocky Mountain Mule Deer, yellow-haired porcupine and snowshoe rabbit which can limit the replacement of aspens and conifers due to heavy browsing pressure. Common small mammals include three species of squirrels, two species of chipmunks, several shrew species, the heavy bat, the Great Basin striped skunk, pika and several rodent species including Citellus, Microtus, Peromyscus and Neotoma of which Peromycus maniculatus is the most abundant. The more common smaller birds include woodpeckers and flycatchers, the rock wren, Western robin, mountain bluebird and the gray-headed Junco (Reference 3-27).

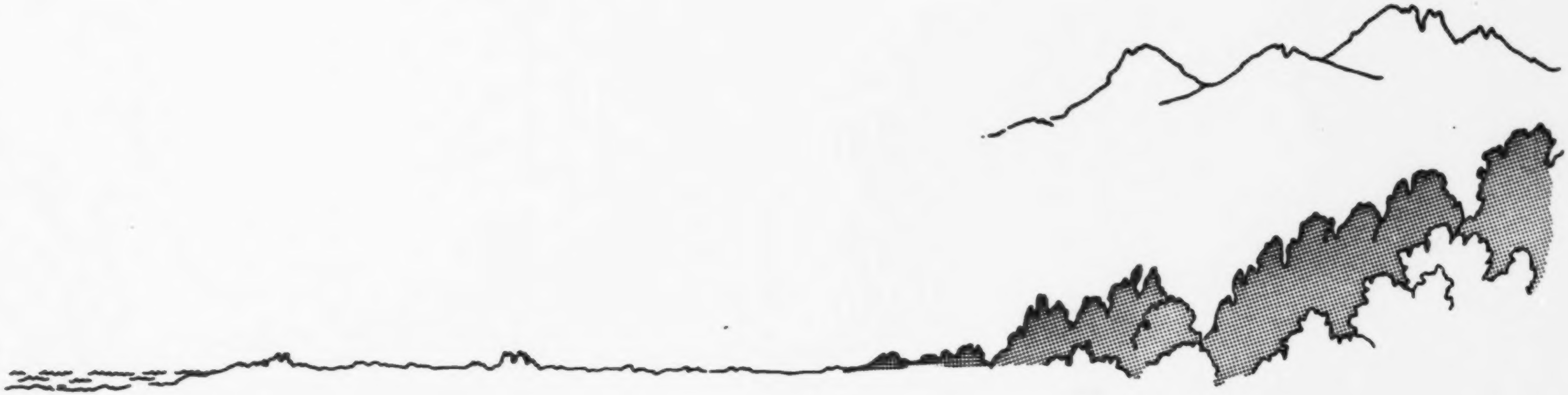


Figure 3-6

Representative Animal Communities

Utah Lake

Canada Goose
Cinnamon Teal
Killdeer
Spotted Sandpiper
Sanderling
American Avocet
Black Tern
Caspian Tern
Forster Tern
California Gull

Channel Catfish
Largemouth Bass
Bluegill
Carp
Black Crappie
Green Sunfish

Coyote
Bobcat
Feral Cat
Common Muskrat
White-footed Deer Mouse
Long-tailed Meadow Mouse
Western Harvest Mouse

Salt Desert/Mixed Brush

Mule Deer
Coyote
Bobcat
Badger
Feral Cat
Black-tailed Jack Rabbit
Desert Audobon Cottontail
White-footed Deer Mouse
Kangaroo Rat

Turkey Vulture
Horned Lark
Common Crow
Western Mourning Dove
Plain Titmouse
Red-shouldered Hawk
Burrowing Owl
Rufous Hummingbird

Grasslands & Foothills

Western Mourning Dove
Ring-necked Pheasant
Gambel's Quail
Wild Turkey
Sage Grouse
Forest Grouse
Red-shafted Flicker
Western Robin
Lazulli Bunting
Rocky Mountain Black-headed Grosbeak
Western Wood Pewee
Montane Horned Owl
Prairie Falcon
Cooper's Hawk

Mule Deer
Coyote
Bobcat
Uinta Ground Squirrel
Black-tailed Jack Rabbit
White-footed Deer Mouse
Desert Woodrat
Long-tailed Meadow Mouse
Badger

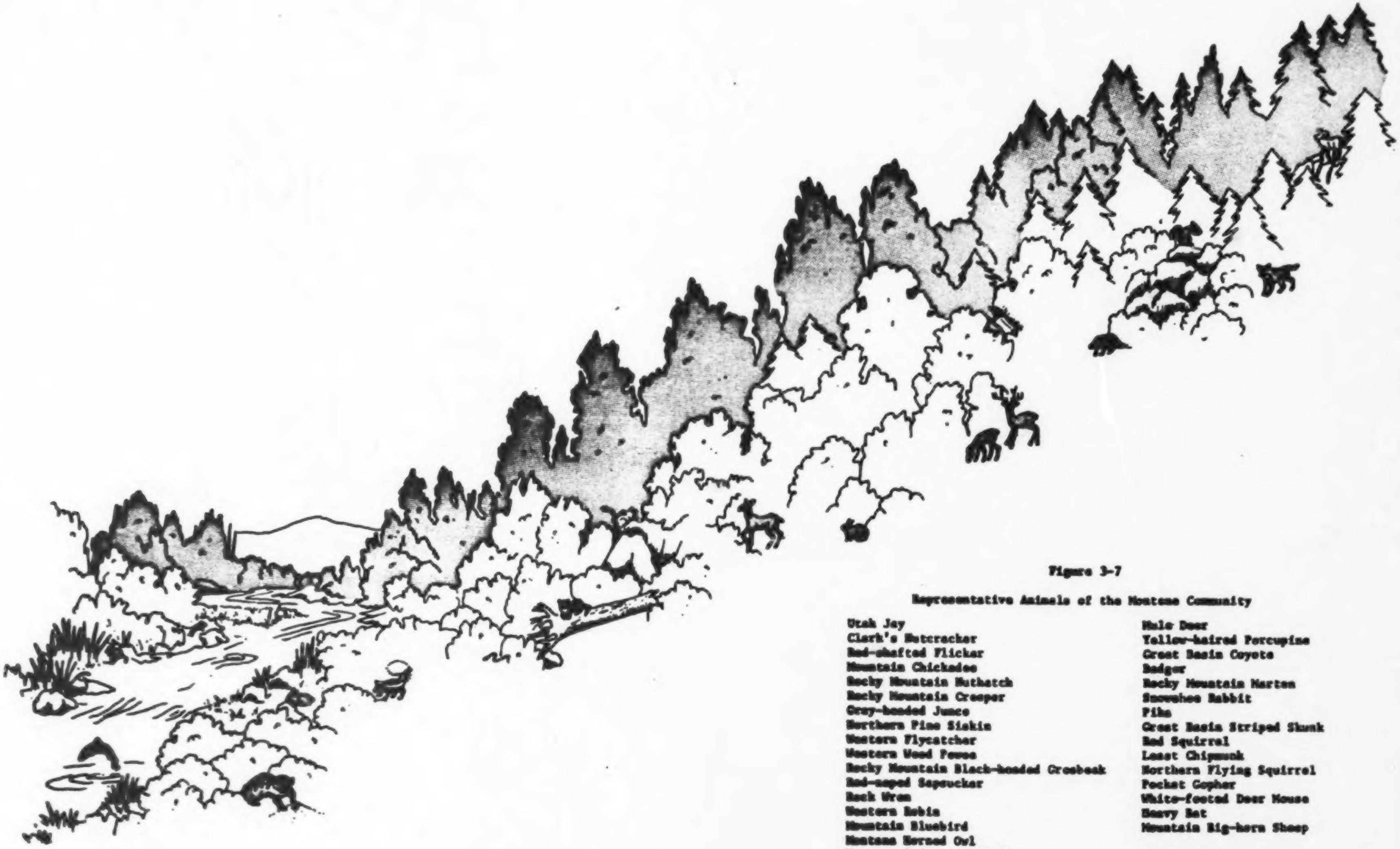


Figure 3-7

Representative Animals of the Montane Community

Utah Jay
Clark's Nutcracker
Red-shafted Flicker
Mountain Chickadee
Rocky Mountain Nuthatch
Rocky Mountain Creeper
Grey-headed Junco
Northern Pine Siskin
Western Flycatcher
Western Wood Pewee
Rocky Mountain Black-headed Grosbeak
Red-naped Sapsucker
Rock Wren
Western Robin
Mountain Bluebird
Montane Horned Owl
Western Red-tailed Hawk
Eastern Goshawk
Cooper's Hawk
Sharp-shinned Hawk

Mule Deer
Yellow-haired Porcupine
Great Basin Coyote
Badger
Rocky Mountain Marten
Snowshoe Rabbit
Pika
Great Basin Striped Skunk
Red Squirrel
Least Chipmunk
Northern Flying Squirrel
Pocket Gopher
White-footed Deer Mouse
Heavy Rat
Mountain Big-horn Sheep

Brown Trout
Rainbow Trout
Brook Trout
Mountain Whitefish

The main predators are the badger, Great Basin coyote and the Rocky Mountain marten. Raptors range down to the valley grasslands and include the Montana horned owl, Western red-tailed hawk and the Eastern goshawk. Other predators and large game such as the black bear, American wapiti or elk, Rocky Mountain bighorn, grizzly bear, wolf, cougar and wolverine have become greatly limited in distribution or extinct from the area (Reference 3-28).

The few reptiles and amphibians present in the montane forest include the smooth green snake, the rubber boa, the common water snake, the tiger salamander and several frog species.

Ants, leafhoppers, aphids, centipedes and beetles are the most important invertebrates in the montane. Each species is generally confined to a particular community, but butterflies, wood-boring beetles and lark beetles of the genus Dendroctonus are widely distributed.

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CHAPTER 4

POPULATION, LAND USE AND ECONOMY

The first white men in recorded history to enter Utah Valley were Spanish explorers led by Silvestre Escalante in 1776. Forty years later, in the early nineteenth century, English and American trappers and prospectors explored the Utah and Salt Lake Valleys. On 24 July 1847, the first permanent settlement was established by a party of Mormon pioneers in Salt Lake Valley. Within two years, Salt Lake City contained 5,000 people and became one of the fastest growing communities in the West.

The members of the Church of Jesus Christ of Latter-Day Saints, more commonly known as the Mormon Church, were leaders in the settlement of Utah Lake-Jordan River area and established many cultural patterns which are described briefly in the following paragraphs as a preface to the discussion of demography, land use and economics.

CULTURE

James Hudson's paper "Irrigation Water Use in the Utah Valley, Utah" (Reference 4-1), published 1962, offers many insights into the culture and lifestyle prevalent in the more rural parts of the basin and is quoted extensively below. On the subject of group feelings, Hudson states:

> "Mormons possess strong group solidarity, resulting from the belief that they are Chosen People. This is heightened by their history, which distinguishes them from other Americans and includes the persecutions in the early days and the great trek westward; by their settlement in villages . . .; and by their strong family ties, in part resulting from Church-promoted interest in genealogy and in part from ethical teachings. In addition, Utah has been synonymous with Mormons for a long period: most American Mormons live in Utah and most Utahns are Mormons. This, together with the long isolation of Utah from the rest of the country, has promoted a local, distinct Mormon culture.
>
> "Using the bee and beehive as their symbols, the Mormons, within the framework of group loyalty and discipline, have become famed for their willingness to work hard and their ability to have their work result in success. In Utah, especially in the early, more fervent days, large amounts of labor were devoted to the development of irrigation systems and of farmland, projects requiring cooperative labor and the postponement of benefits. Often the obstacles were great and the progress discouraging, but effort was persistently, if not stubbornly, invested in order to develop the land they regarded as being given them by the Lord."

Turning to philosophical matters, Hudson adds:

> "Although the Mormon Church distinguishes itself theologically from Protestantism, many of its general ethical teachings are similar to those of traditional American Protestantism. One principle . . . relates to 'everyday economic conduct': it decries idleness, waste, and luxury, advocates 'hard, continuous bodily or mental labour.' A second principle, which the Mormons have in common with Protestantism, is 'the doctrine of John Calvin that financial success was the mark of divine approval.' This devotion to hard work has been accompanied by a sense of the farmer as the steward of the land, and by a drive towards craftsmanship."

Hudson notes that in common with many other parts of the United States, religious ties are weakening in Utah, particularly in the cities; however, the Latter Day Saints Church remains a potent influence in shaping the culture of the Utah Lake-Jordan River area.

POPULATION

Present Population

The total population of the Utah Lake-Jordan River Hydrologic Basins is reported to be 718,638, which is estimated to be 68 percent of the total population of Utah.

The Salt Lake Standard Metropolitan Statistical Area (SMSA) which was modified April, 1974 to the Salt Lake/Ogden SMSA is the largest population center in the state. The SMSA includes the counties of Salt Lake, Davis, Weber and Tooele of which Weber and Tooele lay outside the basin boundaries. Salt Lake County with a reported 1970 population of 458,607 has the greatest concentration of population in both the basins and State. The Provo - Orem Metropolitan Area (Utah County) is second in population with 137,776, followed by Davis County with 99,028. The remaining outlying areas such as those portions of Wasatch, Juab, Sanpete, Weber and Summit Counties in the hydrologic basins have a reported 1970 population of 23,227. A 1970 census showing the population of each population center is presented in Table 4-1. Since 98 percent of the study area population lies within four counties, the demographic analyses are based primarily on data from Davis, Salt Lake, Utah and Wasatch Counties.

Attendant to the expansion of western industry and highways and the rapid population growth, the city-dwelling population has increased heavily along the Wasatch Front. As shown in Table 4-2, the general trend of the past 10 years from 1960 to 1970 has been a shift from rural to urban living.

TABLE 4-1
UTAH LAKE-JORDAN RIVER HYDROLOGIC BASINS

BASIN POPULATION STATISTICS

POPULATION CENTERS

COMMUNITY	POPULATION (1970 Census)
Weber County	
Roy	14,356
Davis County	
Sunset	6,268
Clinton	1,768
West Point	1,020
South Weber	1,073
Clearfield	13,316
Syracuse	1,843
Layton	13,603
Kaysville	6,192
Fruit Heights	800
Farmington	2,526
Centerville	3,268
West Bountiful	1,246
Bountiful	27,853
Woods Cross	3,124
North Salt Lake	2,143
Unincorporated not included above	12,985
Total Davis County	99,028
Salt Lake County	
Salt Lake City	175,885
South Salt Lake	7,810
Magna	8,000
Holladay	25,000
Granger	13,800
Kearns	18,200
Murray	21,206
Midvale	7,840
West Jordan	4,221
Sandy	6,438
South Jordan	2,942
Crescent	
Draper	3,000
Riverton	2,820
Copperton	900
Bingham Canyon	31
Lark	700
Harriman	450
Bluffdale	600
Brighton	50
Alta	40
Unincorporated not included above	158,692
Total Salt Lake County	458,607
Utah County	
Alpine	1,047
Lehi	4,659
American Fork	7,713
Pleasant Grove	5,327
Lindon	1,644
Orem	25,729
Provo	53,131
Springville	8,790
Mapleton	1,980
Lake Shore	30
Benjamin	100
Spanish Fork	7,284
Salem	1,081
Utah County (cont.)	
Payson	4,501
Spring Lake	250
Santaquin	1,236
Genola	424
Goshen	459
Elberta	50
Dividend	——
Birdseye	——
Thistle	50
Mill Fork	——
Gilluly	——
Springdell	——
Vivian Peak	——
Wildwood	——
Unincorporated not included above	12,291
Total Utah County	137,776
Wasatch County	
Wallsburg	347
Charleston	196
Center Creek	358
Heber	3,245
Midway	804
Daniels	366
Unincorporated not included above	547
Total Wasatch County	5,863
Juab County	
Mona	309
Nephi	2,699
San Pete County	
Indianola	——
Summit County	——
Total of Two Hydrologic Basins	718,638

Source: Census of Population 1970 (Reference 4-3).

Table 4-2

Population of Utah Lake-Jordan River Hydrologic Basins
Urban and Rural
1960 and 1970

County	1960			1970			Percent Change, 1960-1970		
	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural
Davis	64,760	51,801	12,959	99,028	85,115	13,913	+ 52.9	+ 64.3	+ 7.4
Salt Lake	383,035	346,295	36,740	458,607	436,201	22,406	+ 19.7	+ 26.0	- 39.0
Utah	106,991	90,167	16,824	137,776	120,554	17,222	+ 28.8	+ 33.7	+ 2.4
Wasatch	5,308	2,936	2,372	5,863	3,245	2,618	+ 10.5	+ 10.5	+ 10.4
Total	560,094	491,199	68,895	701,274	645,115	56,159	+ 25.2	+ 31.3	- 18.5

Source: U.S. Bureau of the Census (Reference 4-4).

Davis, Salt Lake and Utah Counties demonstrated a marked increase in urban population. The rural population of Salt Lake County decreased by 39 percent during the same period. On the other hand, for Wasatch County, urban and rural increases were approximately equal.

The ethnic composition of the Utah Lake-Jordan River area differs from that of the United States. The minority population represents approximately 1.9 percent of the study area population with 0.6 percent Black, 0.4 percent Indian, and 0.9 percent of other races. Representative numbers for the State of Utah are 5.4 percent total, with 0.6 percent Black, 1.0 percent Indian, and 4.0 percent of other races. Racial distribution within the counties is shown in Table 4-3.

Population Projections

Analysis of past population trends, age distribution of the present population, and projections of increasing employment opportunities indicate that the planning area population will more than double in the next 35 years. Comparative population projections from four sources are shown in Figure 4-1. Planning for future water use and wastewater flows and the corresponding treatment facilities will be directly related to the population projections.

To facilitate projections, the study area was divided into subareas or planning areas, as shown in Figure 4-2. Comparisons of population projections for 1970, 1978, 1985 and 1995 from several sources are presented

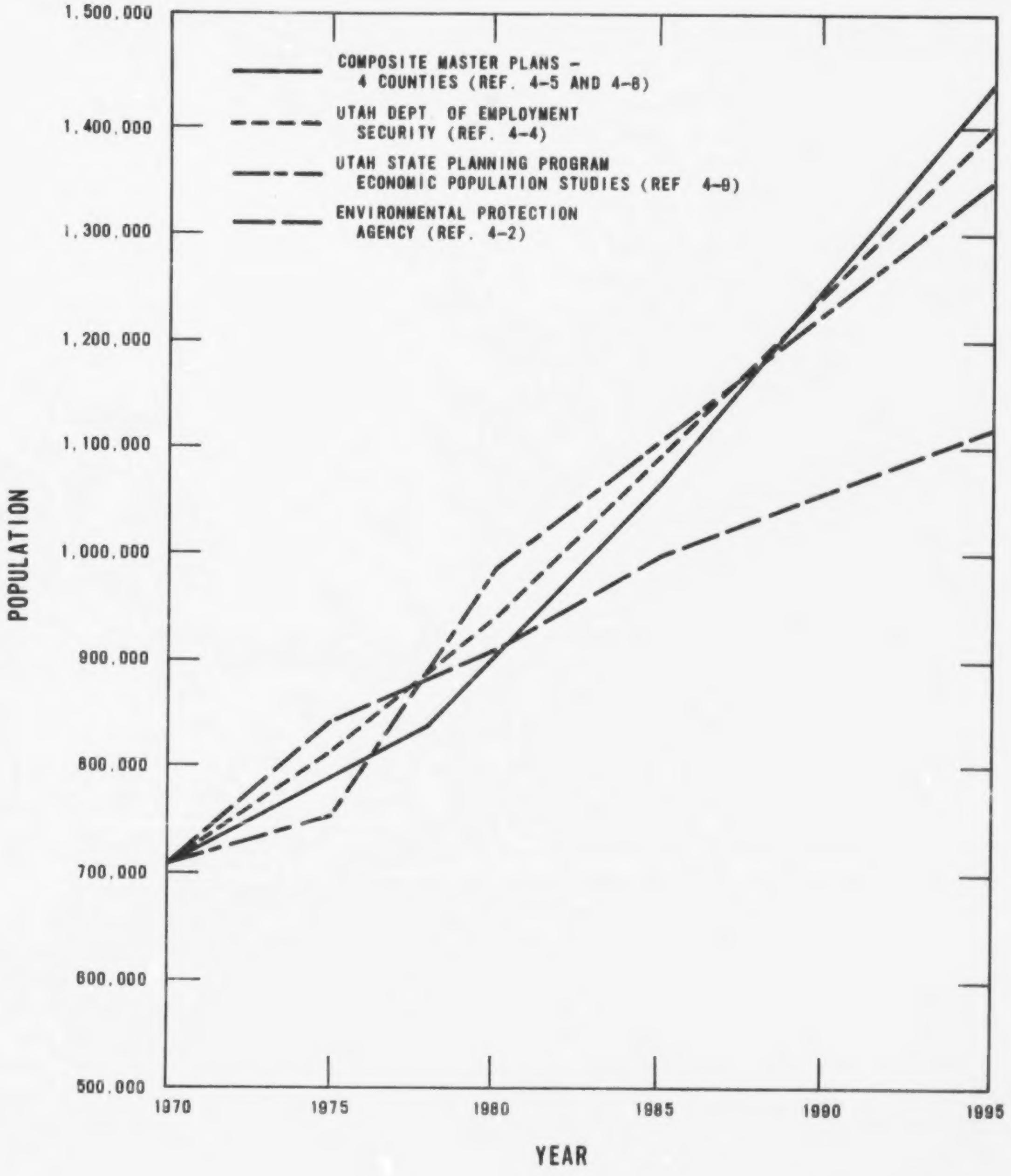
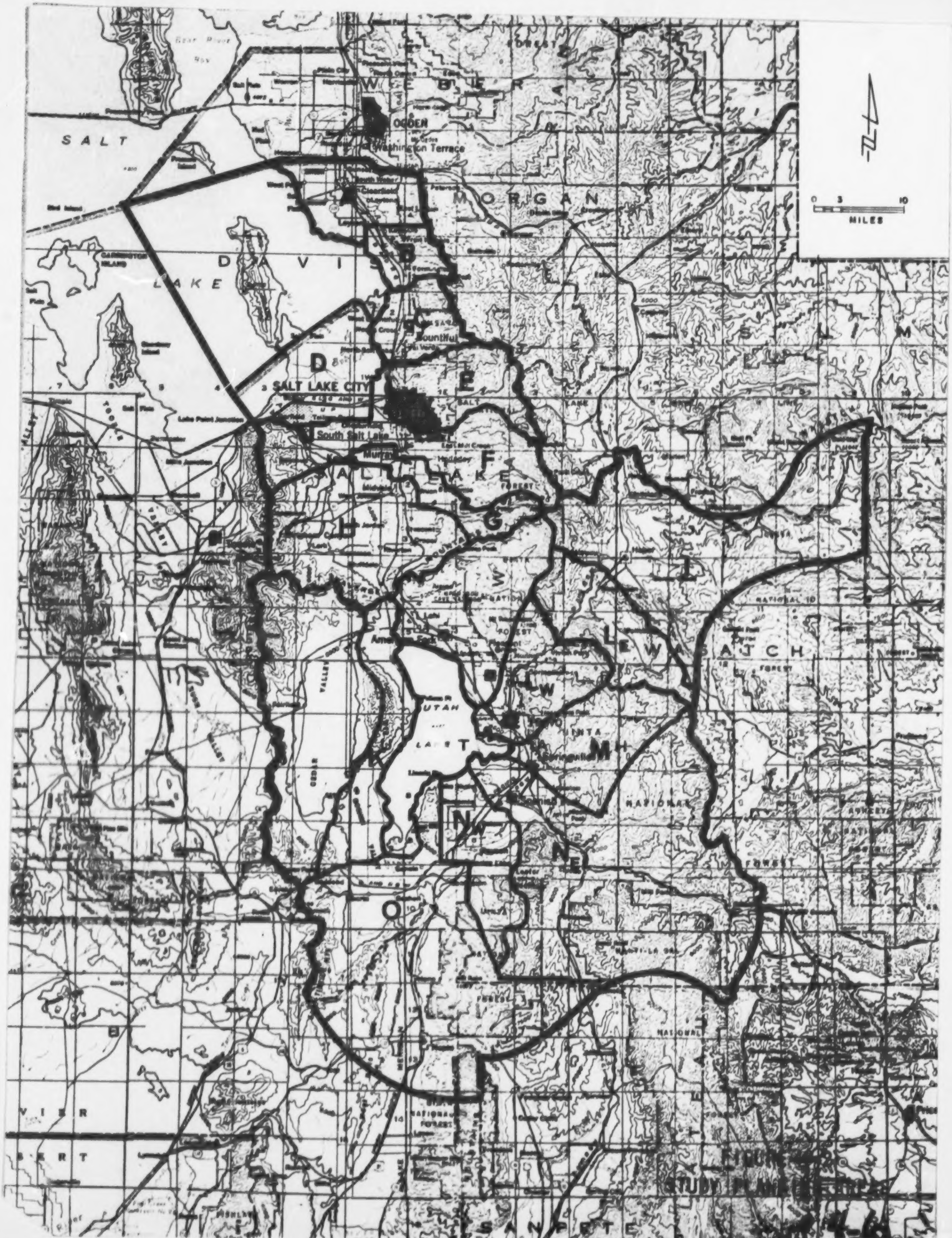


FIGURE 4-1 POPULATION PROJECTIONS FOR UTAH LAKE-JORDAN RIVER HYDROLOGIC BASINS


Bear River Bay
SALT
LAKE
WEBER
OGDEN
Washington Terrace
MORGAN
DAVIS
A
B
C
D
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H
I
J
K
L
M
N
O
Bountiful
SALT LAKE CITY
South Salt Lake
Murray
SALT LAKE
Lake Point Junction
WASATCH
UTAH
LAKE
Springville
NATIONAL
FOREST
MANTI-LA SAL
SANPETE
N
0 3 10
MILES
FIGURE
STUDY PLANNING UNITS

Table 4-3

Racial Distribution in the Study Area

County	White		Negro		Indian		Other		Total
	1970	Percent	1970	Percent	1970	Percent	1970	Percent	
Davis	96,057	97.0	1,723	1.7	388	0.4	860	0.9	99,028
Salt Lake	449,781	98.0	2,473	0.5	1,617	0.4	4,736	1.1	458,607
Utah	136,266	98.9	47	0.1	613	0.4	850	0.6	137,776
Wasatch	5,847	99.7	0	0.0	10	0.2	6	0.1	5,863
Total	687,951	98.1	4,243	0.6	2,628	0.4	6,452	0.9	701,274

Source: U.S. Bureau of the Census (Reference 4-4).

in Table 4-4. Basic population data were taken from the Davis County Master Plan, the Comprehensive Water and Sewer Plan for Wasatch County, the Salt Lake Area Transportation Study and Utah Valley Transportation Study.

Table 4-4

Present and Projected Population by County

County	1970	1978	1985	1995
Davis	99,028	160,338	189,014	241,000
Salt Lake	458,607	595,605	666,535	808,407
Utah	137,776	174,480	200,931	243,730
Wasatch	5,863	7,550	8,420	9,820

Source: References 4-5, 4-6, 4-7, 4-8

Davis County was divided into three planning areas: north, central and south. A portion of Weber County encompassing the City of Roy is included in planning area 'A.' The greatest population increases are anticipated in the north and central parts of the county, particularly at Layton, Farmington and Kaysville.

Salt Lake County comprises five planning areas designated 'D' through 'H.' Population of the county is expected to increase 77 percent by 1995, with growth concentrated in the Salt Lake City suburbs of Granger, Kearns, Taylorsville, Murray, Sandy, West Jordan, South Jordan, Riverton, Bluffdale, and the Cottonwood area. Planning area 'E', which includes Salt Lake City, is the most densely populated area within the study area and the State of Utah.

Utah County was divided into six planning areas. A portion of Juab County is included in the planning area 'O'. Population of the county is expected to increase 64 percent by 1995, a lower rate than that for Salt Lake County. The highest growth rates are expected in the northern part of the count near Orem and in the Mapleton City area southeast of Springville.

Planning area 'J' includes those portions of Wasatch and Summit Counties that lie within the basins. The population of this area is expected to increase 68 percent by 1995.

LAND USE

Information on present and projected land use was obtained from the county master plans and the Utah and Salt Lake County Transportation studies (References 4-10 and 4-11). The total land area within the basins is 2.2 million acres or 3,446 square miles.

Present Land Use

Land within the basin is owned by federal and state agencies and many private entities and individuals. Federal lands are managed by the U.S. Forest Service, U.S. Bureau of Land Management and U.S. Department of Defense. The State of Utah owns numerous parks, wildlife refuges and recreation areas. Private land areas consist of city, railroad, industrial, church and individual holdings. Proportional land ownership in the basins is shown in Figure 4-3.

Figure 4-4 shows the proportions of land in various land-use categories in 1970. Two-thirds of the land is occupied by forest and mountain areas. Within the remaining third, the developed areas, agricultural land use predominates.

The canyons and peaks of the Wasatch Front are used extensively for both winter and summer recreation and in many areas as a water supply catchment for Salt Lake City. Residential development of the canyons is

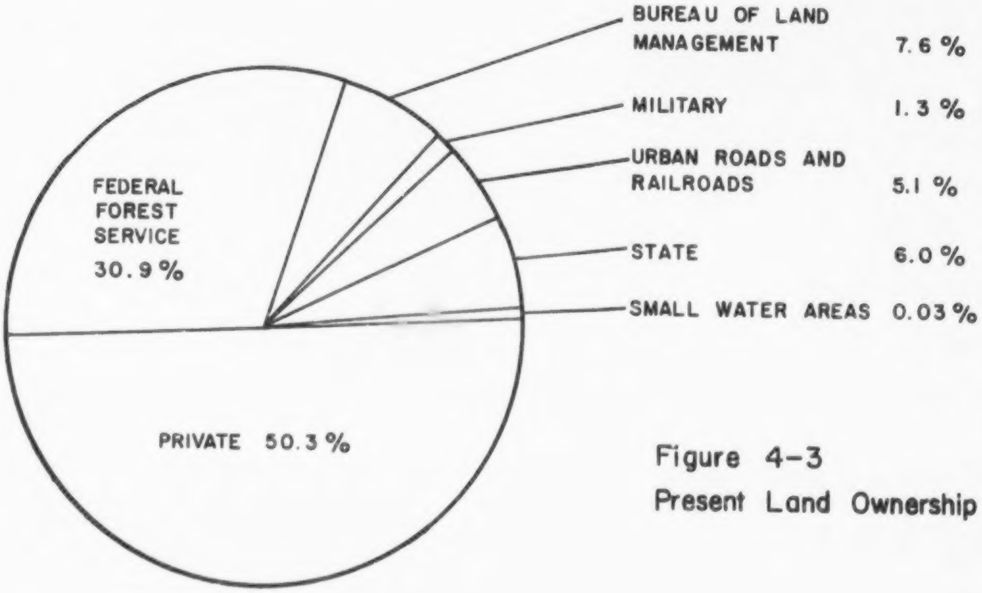

Figure 4-3
Present Land Ownership

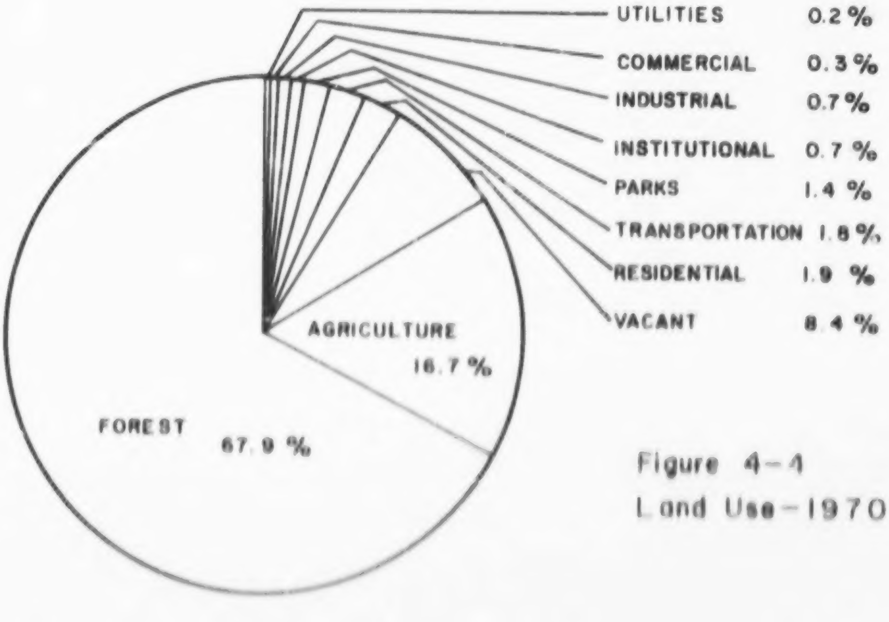

Figure 4-4
Land Use-1970

1970

minimal at present; however, pressure for development of winter recreation resorts is increasing. Reconciling the conflicting land-use requirements for recreation and watershed protection is one of the most serious environmental problems faced within the basins.

Projected Land Use

Table 4-5 shows projected acreages of various developed land-use categories for the year 1995. Figure 4-5 shows the relative proportions of each land-use category. All urban land-use categories including residential, commercial, industrial, transportation, institutional, utilities and parks and recreation show increases, while agricultural and vacant lands show decreases.

The largest land-use increases, 75 and 67 percent, are anticipated in the residential and commercial categories, respectively. Land requirements for schools, hospitals and other public buildings classified as institutional use is expected to increase by 46 percent. The low population density prevalent in the study area leads to a high land requirement for transportation purposes which is expected to increase by a further 36 percent by 1995. Agricultural acreage, which presently comprises 52 percent of the developed land within the basins, is expected to decrease by 9 percent.

LOCAL ECONOMY

The economy of the Utah Lake-Jordan River area has experienced substantial and steady growth in recent years, and the outlook is for continuing prosperity in the decade ahead. The local economy is diversified and based upon industries that will share in the growth of the national ecomony. Because of the geographic location of the state, a considerable investment has been made in developing trade and distribution centers for the West. The rich endowment of natural resources has provided a significant part of the economic base in the production of copper, steel, oil and agricultural industries. Since the end of World War II, manufacturing industries have experienced rapid growth and now comprise the second largest income-producing sector of the economy (References 4-13 and 4-14).

TABLE 4-5

PRESENT AND PROJECTED LAND USE IN ACRES

Planning Area	Residential		Commercial		Industrial		Transportation		Institutional		Utilities	
	1970	1995	1970	1995	1970	1995	1970	1995	1970	1995	1970	1995
Davis County												
A	1965	5135	742	846	273	1020	2655	3814	6578	6768	230	261
B	713	1955	81	165	44	75	1301	1623	450	673	44	58
C	2448	4285	237	425	491	1010	1930	2060	305	950	69	39
S.L. County												
D	633	1392	239	500	8566	5000	2314	6520	53	130	350	450
E	7507	8494	1695	1937	1334	1492	7674	9360	2839	4223	253	348
F East	7502	10394	943	1610	570	1101	3806	4641	793	1522	388	549
F West	3557	7531	497	965	442	999	1840	3039	512	1117	231	295
G East	4020	8064	406	878	502	593	2005	3199	455	1014	187	311
G West	1145	2699	64	286	20	35	873	1281	227	565	193	269
H East	2451	5209	166	415	539	368	2266	3513	515	877	506	675
H West	1342	3720	34	240	108	235	916	1550	94	400	232	285
Utah County												
I	3981	6766	400	916	1722	2207	4372	5040	606	1201	450	525
K	-	-	-	-	-	-	-	-	-	-	-	-
L	1827	2493	319	521	902	1376	2196	2379	636	879	104	110
M	976	1639	174	321	89	517	1187	1314	113	235	143	156
N East	757	1150	110	170	174	264	1373	1405	94	220	68	72
N West	787	1039	109	188	53	113	1621	1671	82	131	204	216
So. Utah and Juab County												
O	411	411	43	43	16	16	485	485	NA		113	113
Wasatch County												
J	359	509	36	86	13	13	404	444	NA		94	144
TOTAL	42381	72885	6295	10512	15858	16434	39218	53338	14352	20905	3785	4796

NA - Not Available

Columns may not total exactly due to rounding off

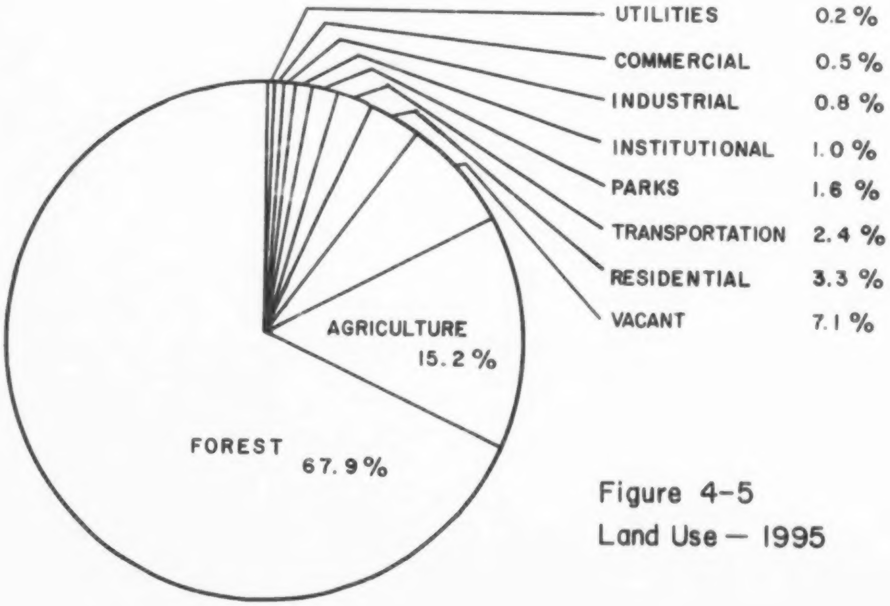

Figure 4-5
Land Use — 1995

1995

Service industries such as recreation, tourism, education and medical care have grown rapidly in recent years, more than keeping pace with developments in the national economy (References 4-4 and 4-15).

Employment

In 1971, the civilian work force in the Utah Lake-Jordan River area averaged 310,600, which was approximately 75 percent of the total State of Utah labor force. Civilian work force and employment for the four major counties in the study area is shown in Table 4-6: 292,500 workers were employed and 17,450, or 5.6 percent were unemployed. Of the total employment, 90.6 percent was in nonagricultural sectors, while 8.4 percent were self-employed and 1.0 percent were in agricultural sectors. Agricultural employment generally represented a very small amount of the work force, from 0.5 percent in Salt Lake County up to 7.7 percent in Wasatch County.

Distribution of employees on nonagricultural payrolls within the four major counties of the study area is presented in Table 4-7. Areas of major employment are government, trade, services and manufacturing.

Income from agriculture, self-employment, property rentals, transfer payments such as social security, welfare and retirement benefits, dividends and interest account for about 30 percent of the income in Utah Valley. The balance of approximately 70 percent is in the form of wages and salaries in industries.

Total personal income of the Utah Lake-Jordan River area increased from $1,200 million in 1960 to $2,640 million in 1971. Per capita personal income for the study area was $3,270, compared to the national average of $4,156. The Utah average for 1971 was comparable to the study area at $3,442. Per capita income distribution for the four major counties of the study area is shown in Table 4-8. For 1971, Salt Lake County had the highest average income, $4,020, while Utah County had a low average of $2,400.

Major Industries

Manufacturing--

In 1971, manufacturing firms within the basin employed 40,723 workers, or approximately two-thirds of the state total. Wages from manufacturing in the state amounted to more than $478 million. Large concerns such as

Table 4-6

Employees on Nonagricultural Payrolls in the Utah Lake-Jordan River Planning Area by Major Industry Group, 1971

County	Total Nonagricultural Employees	Manufacturing	Mining	Construction	Transportation, Communications and Utilities	Trade	Finance Insurance, and Real Estate	Services and Miscellaneous	Government
Davis	32,899	3,060	36	967	na	3,750	430	2,240	21,575
Salt Lake	191,340	29,143	7,037	9,661	15,257	50,410	11,467	32,441	35,926
Utah	38,858	8,404	406	1,821	1,458	7,219	943	11,986	6,621
Wasatch	1,798	116	404	214	49	332	43	196	445
Total	264,057	40,723	7,883	12,663	16,764	61,711	12,883	46,863	64,567

Source: Utah Department of Employment Security (Reference 4-4).

Table 4-7

Utah Lake-Jordan River Hydrologic Basins Civilian Work Force and Employment 1971

County	Work Force	Employment				Total Unemployment
		Total	Agricultural	Self-Employed	Employees on Nonag. Payrolls	
Davis	37,200	35,500	490	2,100	32,899	1,700
Salt Lake	223,500	210,900	940	18,600	191,340	12,100
Utah	47,400	43,900	1,300	3,740	38,858	3,400
Wasatch	2,500	2,200	170	230	1,798	250
Total	310,600	292,500	2,900	24,670	264,895	17,450

Source: Utah Department of Employment Security (Reference 4-4).

Kennecott Copper Corporation and United States Steel Company, together with other firms in the primary metals industry, paid more than $92.6 million of the total $478 million. Significant segments in addition to primary metals, measured by value added, are food processing ($103 million); machinery except electrical ($67.5 million); petroleum refining and related industries ($44.1 million); and fabricated metal products ($63.6 million).

A major portion of Utah's growth in manufacturing occurred after 1940. Since that time, United States Steel has purchased and expanded the Geneva Steel Works in Utah County. The state's primary metal firms have increased production, and processing of ores, metal fabrication and machinery production have become more important. An added stimulus to the state's economy has been the entry of local industry into the production of fuels and parts for the missile industry. Since 1967, industries which have shown rapid growth are electronics, bioengineering and transportation equipment (trailers, campers, mobile homes).

Trade--

The Utah Lake-Jordan River study area is a major distribution point for Utah and the western slope of the Rocky Mountains. The state's market orientation is toward the West Coast, and Utah provides a secondary market for distribution centers located in that area.

Retail and wholesale trade provided 61,711 jobs in 1971, the second largest employment sector in the study area.

The total volume of business activity for Utah has increased 71 percent during the last five years. When sales volume is adjusted for changes in the consumer price index, the increase between 1967 and 1972 amounts to 36 percent. By comparison, the adjusted rise during the preceding five-year period 1962 to 1967 amounted to only 10 percent. Approximately 56 percent of gross sales occurred in Salt Lake County, with 12 percent in Weber County, 10 percent in Utah County and smaller percentages in each of the other counties.

Government--

In 1971, the government sector of the basin economy employed the largest number of people: 64,567, or 61.4 percent of total employment in the state. Government employment has increased at a faster rate than any other

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sector. The largest increases occurred between 1965 and 1967, during which time government employment grew 23 percent per annum, principally as a result of increases in personnel at Hill Air Force Base in Davis County. Since that time the growth rate of government employment has slowed to 7.7 percent per annum.

Services--

Paralleling the national trend, the service sector of the basin economy has grown rapidly over the past decade. In 1960, services employed 24,700 persons, or 13.5 percent of the total employment. By 1971 employment had grown to 46,863 and accounted for almost 18 percent of the total nonagricultural employment.

The major components of the services sector are medical, health and private educational services. Within recent years, one of the most rapidly growing components was services to businesses.

Agriculture--

Following the national trend, farm employment in Utah has declined since 1960; however, farm size and productivity have both increased. Farm proprietors' income has fallen from 2.7 percent of total personal income in 1966 to 1.5 percent in 1972.

Major farm commodities, in order of value, are cattle, dairy products, turkeys, sheep and chickens and eggs. Income from crops is generally less than from livestock and livestock products. Major crops include hay, wheat and sugar beets. A percentage breakdown of cash receipts from Utah agricultural products is shown in Figure 4-6, and the market value of all agricultural products sold in the Utah Lake-Jordan River basin is shown in Table 4-9.

Mining--

Since 1940 there has been a general expansion in the production of metals and other mined materials. Heavy mining activity in Utah is concentrated in the West Mountain or Bingham district. This district, in the Oquirrh Mountains west of Salt Lake City, is a major producer of copper, silver, lead, zinc, gold and molybdenum and incidental amounts of by-product precious and rare metals and sulfuric acid. Both within the study area and in the State of Utah as a whole, copper is the most important mineral resource.

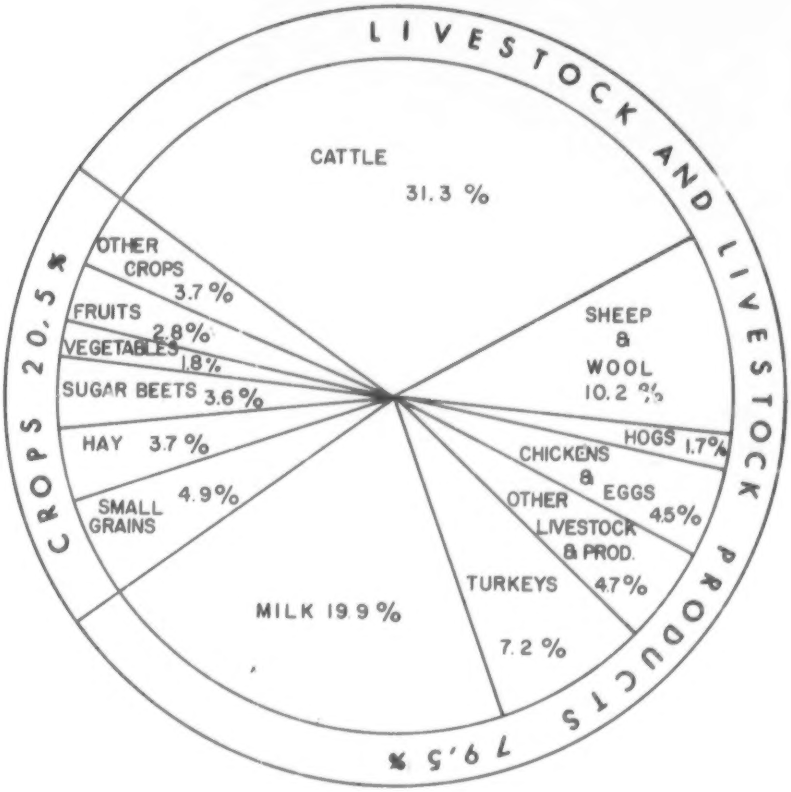

Figure 4-6
Cash Receipts by Commodities,
Utah, 1969

Table 4-9

Market Value of All Agricultural Products Sold
1969
(Dollars)

County	Total	Crops Including Nursery Products	Forest Products	Livestock and Poultry Products
Davis	10,087,322	3,026,452	-	7,060,870
Salt Lake	14,546,696	3,814,122	750	10,731,824
Utah	26,363,102	5,814,881	1,228	20,546,993
Wasatch	3,536,865	174,338	-	3,362,527

The Kennecott Copper Mine at Bingham Canyon produces 90,000 tons of ore daily and is the largest open-pit copper mine in the world. About one-third of the state's mineral production is currently from Salt Lake County and largely from the Bingham district.

Mineral production for Utah in 1972 was valued at $536.8 million, of which copper accounted for approximately 52 percent, petroleum 15 percent and coal 6 percent.

Recent developments in the mining industry include the opening of commercial mining and milling operations for the production of beryllium and the investment of more than $100 million for the extraction of brines from the Great Salt Lake for the production of magnesium, chlorine, magnesium chloride, potassium sulfate, sodium sulfate and sodium chloride.

Tourism--

Tourist services have grown with the expansion of Utah's travel and recreation industry. Popular recreational areas include Timpanogos Cave National Monument, Camp Floyd, Deer Creek Lake, Great Salt Lake, Pioneer Lake and Utah Lake. The number of visits to parks, monuments and recreation areas has increased greatly since 1966, as shown in Figure 4-7. Winter recreation is focused upon the ski resorts such as Alta, Snowbird and Brighton along the Wasatch Front. Skier visits to Salt Lake County resorts were 310,000 for the 1971-72 season and were estimated to be 462,000 for the 1972-73 season. Attendant service industries presently accommodate 2,015 guests daily and employ 618 persons. Future ski resort developments propose to accommodate 10,758 guests daily and employ 2,784 people (Reference 4-17). In the fiscal year 1972, over eight million out-of-state travelers spent more than $146 million in the state, making tourism one of Utah's largest income-producing industries.

Economic Development

In 1971, 310,600 people were employed in the Utah Lake-Jordan River study area. Based on the annual growth averages for each county, as shown in Table 4-10, the long-term growth rate of nonagricultural employees has been an approximate five percent per annum since 1960. Short-term averages, on the other hand, vary widely, especially in small counties such as Wasatch and Davis.

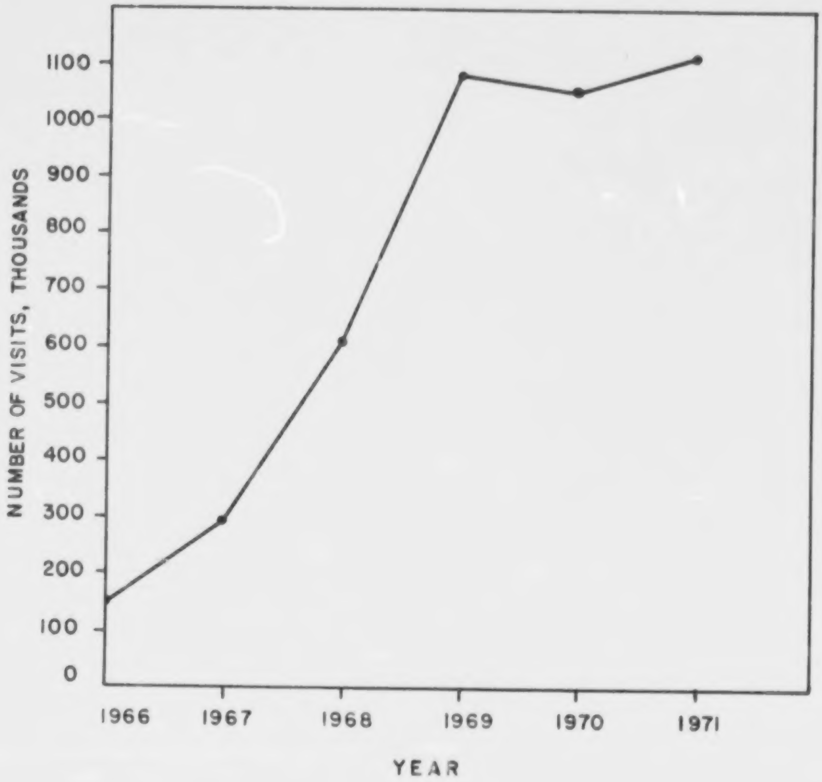

FIGURE 4-7
NUMBER OF VISITS TO STATE PARKS, MONUMENTS AND RECREATION AREAS
1966–1971

Table 4-10

Annual Rate of Growth of Employees on Nonagricultural Payrolls

by Major Industry Group

1960-1971

Industry	Davis County		Salt Lake County		Utah County		Wastach County		US
	1960-71	1969-71	1960-71	1969-71	1960-71	1969-71	1960-71	1969-71	1960-72
Manufacturing	NA	NA	2.2	2.2	0.9	-4.5	10.4	9.7	1.0
Mining	-3.8	0	0.5	-3.1	21.6	4.2	NA	-3.0	-1.3
Construction	0.2	23.0	2.2	16.5	2.1	8.9	48.1	22.7	1.7
Transportation	NA	NA	1.7	1.2	1.9	4.9	NA	4.4	0.9
Trade	9.3	9.4	3.4	3.4	4.9	6.5	2.2	-4.5	2.7
Finance	6.9	7.1	3.1	4.0	5.3	6.6	NA	19.3	3.3
Services	24.4	-0.3	6.7	5.7	11.3	7.5	3.6	9.3	4.3
Government	4.5	-0.1	6.8	5.0	4.7	2.8	8.0	11.6	4.0
TOTAL	5.3	1.8	3.8	4.0	4.8	3.3	5.9	4.7	2.5

NA - Not Available

By far, the largest number of nonagricultural employees is in Salt Lake County. Studies based on employment projections by the University of Utah Bureau of Business and Economic Research indicate the total number of workers in Salt Lake County will approximately double by 1985. The projected percentage distribution of workers from 1975 to 1985 is presented in Table 4-11. The greatest increase in employment is expected in light industry, retail trade, services and government. This projection assumes a continuation of present economic trends with a continuing demand for light manufacturing to supply local and out-of-state markets and an expansion of retail trade, services and government in response to the growing population. Areas with a probable stabilization or decrease in number of employees are agriculture, mining, construction and finance.

The current and projected industrial areas along the Wasatch Front is shown in Figure 4-8.

Table 4-11

UTAH LAKE-JORDAN RIVER HYDROLOGIC BASIN
PROJECTED PERCENTAGE DISTRIBUTION OF CLASSIFIED WORKERS
1975, 1980, 1985

	Employment Category	Salt Lake SMSA[a]			Provo SMSA[b]		
		1975	1980	1985	1975	1980	1985
1.	Agriculture	0.8	0.7	0.5	4.6	3.6	2.8
2.	Mining and Mineral Production	2.3	1.9	1.5	0.3	0.2	0.2
3.	Manufacturing	10.6	9.7	8.8	18.1	17.0	16.0
4.	Defense	4.4	3.7	3.1	-	-	-
5.	Government	19.4	21.0	22.7	19.7	22.0	24.4
6.	Construction	6.8	6.9	6.8	4.8	4.8	4.6
7.	Transportation, Communications and Utilities	6.4	5.5	4.8	2.8	2.5	2.2
8.	Wholesale and Retail Trade	25.5	25.2	24.7	17.0	17.2	17.4
9.	Finance, Insurance and Real Estate	6.7	6.9	7.1	2.3	2.5	2.8
10.	Services	17.1	18.5	20.0	30.5	30.2	29.6
	TOTAL	100.0	100.0	100.0	100.0	100.0	100.0

[a] Salt Lake SMSA includes Salt Lake County and South Davis County.

[b] Provo SMSA includes Utah County

Source: Bureau of Economic and Business Research, University of Utah (Reference 4-3).

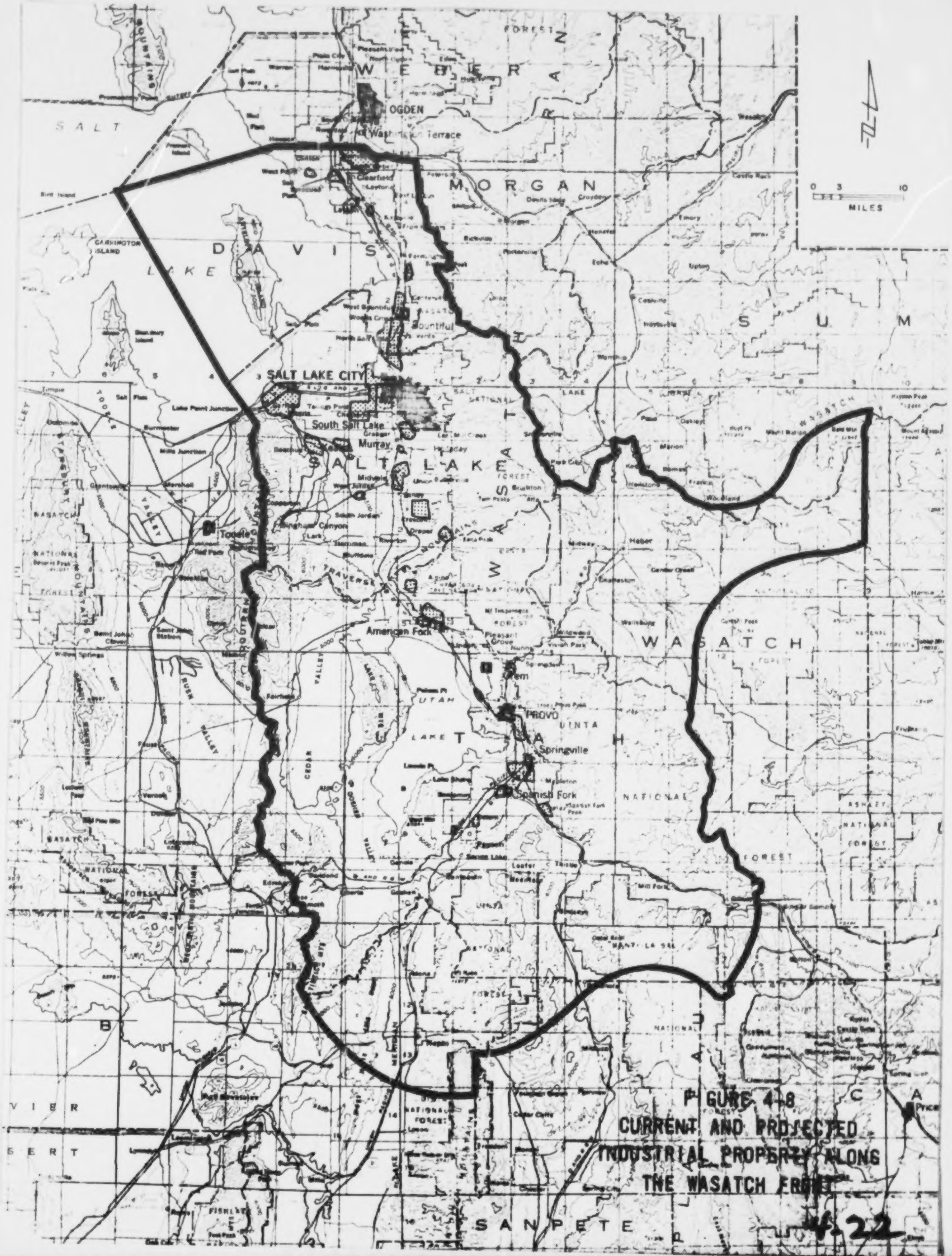
WEBER
OGDEN
Washington Terrace
SALT
MORGAN
Clearfield
Layton
DAVIS
LAKE
Bountiful
SALT LAKE CITY
South Salt Lake
Murray
SALT LAKE
Midvale
Tooele
Bingham Canyon
American Fork
Pleasant Grove
Orem
PROVO
UTAH
LAKE
Springville
Spanish Fork
WASATCH
Heber
S U M
UINTA
NATIONAL
FOREST
SANPETE
0 3 10
MILES

FIGURE 4-8
CURRENT AND PROJECTED
INDUSTRIAL PROPERTY ALONG
THE WASATCH FRONT

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CHAPTER 5

EXISTING WASTEWATER COLLECTION, TREATMENT, AND DISPOSAL FACILITIES

When the Salt Lake and Utah Valleys were first settled, wastewaters were disposed of to the groundwater by means of individual pit privies and, in later years, by septic tanks. As population density increased, this method of waste disposal became increasingly unsatisfactory, particularly as the high water table and impermeable clay soils characteristics of the valley bottoms do not lend themselves to land disposal of wastewaters.

In 1889, work commenced in Salt Lake City on the first sewage collection system in the study area. As more cities and towns were incorporated, sewage collection systems proliferated. In early days, the focus of wastewater management was protection of the public health by means of efficient collection of wastes and transport to locations remote from human habitation. Treatment facilities were rare and if they existed, were usually some form of communal septic tank. In the 1950's, with a booming population, increasing attention was paid to sewage treatment. By 1970, all the larger municipalities or sewage improvement districts were operating secondary treatment plants.

An inventory and brief description of the existing municipal and industrial wastewater facilities in the study area is preceded by a description of the existing institutional arrangements for sewage collection, treatment, and disposal. Financing of the facilities is discussed in a later section.

Information pertaining to industrial wastewater management practices was obtained exclusively from the Corps of Engineers discharge permit application forms which were mainly prepared using information from State files while corresponding data for municipal systems were gathered from a number of sources. The inventory presented in this chapter accounts for all industries with discrete wastewater discharges to the surface waters of the basins rather than to municipal sewer systems. Municipal wastewater treatment plants described in this chapter serve approximately 94 percent of the total population in the Utah Lake-Jordan River Hydrologic Basins. The remaining six percent of the population is unsewered and is located in the unincorporated areas and smaller communities of the study area as indicated by the information in Table 5-1.

Table 5-1

SEWERED AND UNSEWERED POPULATION

Planning Area	Sewered Population	Unsewered Population	Total
Davis County (1970 Census)			
A	55,090	3,542	58,632
B	9,518	0	9,518
C	45,234	0	45,234
Total County	109,842	3,542	113,384
Salt Lake County (1970 Census)			
D	9,992	0	9,992
E	174,870	0	174,870
F	147,287	0	147,287
G	74,816	0	74,816
H	26,725	19,340	46,065
Total County	433,690	19,340	453,030
Utah County (1971 UVATS)			
I	47,942	5,428	53,370
K	0	295	295
L	56,257	3,539	59,826
M	9,314	2,846	12,160
N	13,705	3,416	17,121
O	0	2,817	2,817
Total County	127,218	18,341	145,589
Juab County (1971 UVATS)			
O	2,740	305	3,045
Total County	2,740	305	3,045
Wasatch County (1970 Census)			
J	4,049	1,814	5,863
Total County	4,049	1,814	5,863
TOTAL BASIN	677,539	43,342	720,911

INSTITUTIONAL ARRANGEMENTS FOR WASTEWATER MANAGEMENT

Responsibility for collection, treatment and disposal of sewage in the study area is shared by a multitude of entities. Industrial wastes are either treated and disposed of by the individual industry or discharged to a municipal sewerage system. Municipal sewerage service is provided by the municipalities themselves, or by improvement districts. The municipalities are general purpose governments with a variety of functions including sewerage service. Improvement districts, on the other hand, are created for the single purpose of providing water and sewer service to areas within their jurisdiction.

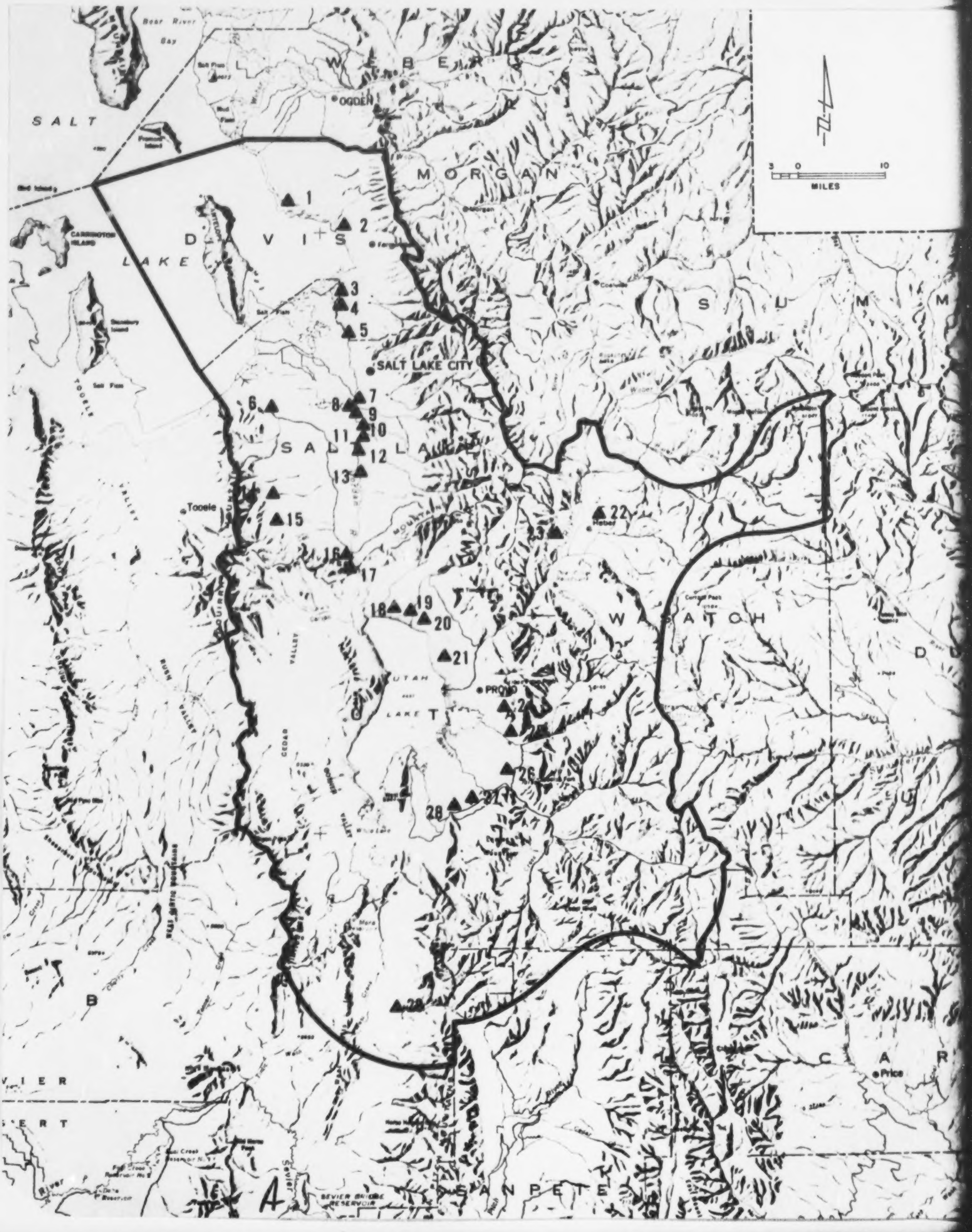
In Utah and Wasatch Counties municipalities are, without exceptions, responsible for sewage collection, treatment and disposal. In Salt Lake and Davis Counties wastewaters are managed by both municipalities and improvement districts.

EXISTING MUNICIPAL WASTEWATER FACILITIES

The areas served by municipal sewage collection systems are shown in Figure 5-1. The locations of the 29 existing wastewater treatment facilities are shown in Figure 5-2. Twenty-three of the 29 existing wastewater treatment plants in the study area utilize the trickling filter process and account for approximately 98 percent of the total daily volume of wastewater treated. Table 5-2 summarizes certain characteristics of the individual plants.

Trickling Filter Process Description

Trickling filters operate on the principle of biochemical oxidation of organic matter in wastewater. The microorganisms responsible for oxidation develop as a slime attached to the rock media in the filter. Wastewater is applied to the top of the filter and as it trickles down over the media, the attached organisms utilize the organic matter for cell synthesis. Oxygen is supplied both from dissolved oxygen in the sewage and from the circulation of air through the voids between the rock media. BOD removal in the filter generally depends on the amount of biological slime and the length of time the wastewater is in contact with the microorganisms. The microorganisms attain a life-cycle equilibrium and the dead biota slough


Bear River Bay
SALT
LAKE
WEBER
OGDEN
MORGAN
DAVIS
CARRINGTON ISLAND
SALT LAKE CITY
SUMM
SALT LAKE
TOOELE
Tooele
VALLEY
RUSH VALLEY
CEDAR VALLEY
UTAH LAKE
PROVO
Heber
WASATCH
DU
U
CAR
Price
B
VIER
ERT
SEVIER BRIDGE RESERVOIR
SANPETE
MILES
3 0 10
1
2
3
4
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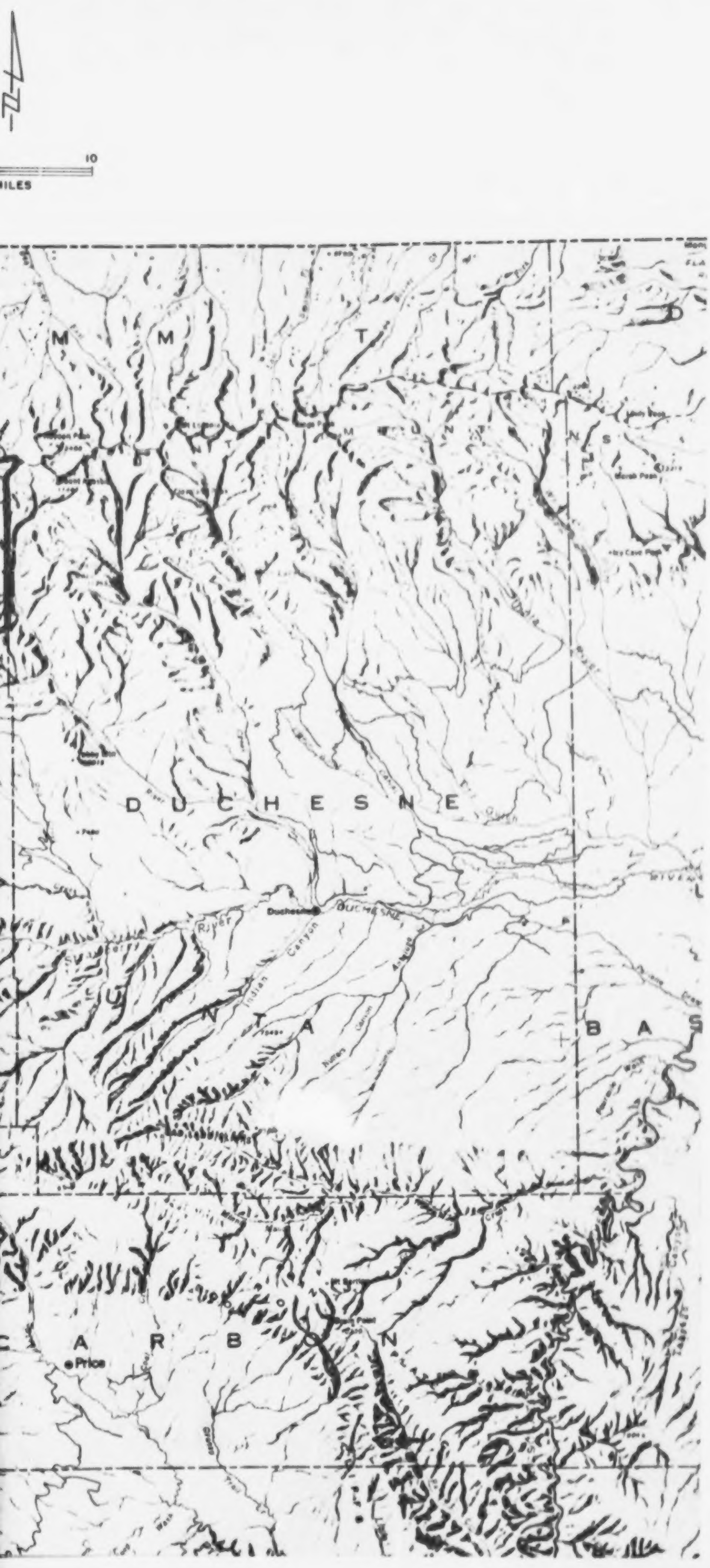
10
MILES
M
M
T
N
S
DUCHESNE
Duchesne
DUCHESNE
River
Indian Canyon
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A
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A
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C
A
R
B
O
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Price

LEGEND

— STUDY AREA BOUNDARY
▲ WASTEWATER TREATMENT PLANTS
1. NORTH DAVIS
2. CENTRAL DAVIS
3. SOUTH DAVIS NORTH
4. SOUTH DAVIS SOUTH
5. SALT LAKE CITY
6. MAGNA
7. SOUTH SALT LAKE
8. GRANGER HUNTER
9. SALT LAKE SUBURBAN #1
10. COTTONWOOD
11. MURRAY
12. TRI COMMUNITY
13. SANDY
14. COPPERTON
15. LARK
16. STATE PRISON
17. CAMP WILLIAMS
18. LEHI
19. AMERICAN FORK
20. PLEASANT GROVE
21. OREM
22. HEBER
23. MIDWAY
24. PROVO
25. SPRINGVILLE
26. SPANISH FORK
27. SALEM
28. PAYSON
29. NEPHI

FIGURE 5-2
EXISTING MUNICIPAL WASTEWATER
TREATMENT PLANTS

B

off the media and constitute a portion of the suspended solids in the effluent. These biological solids, along with other solids are removed in a clarifier downstream of the filter.

In most trickling filter plants, a portion of the filter effluent is recycled to the influent of the filter. This procedure has several advantages, including "seeding" the influent with active microorganisms and providing additional oxygen to aid in biochemical oxidation of organic material and control of odors. Recycle operation also helps to attenuate variation in flow and organic loading (lbs. BOD/ft^3 media).

Nitrification, the oxidation of ammonia to nitrate, in wastewaters can be accomplished in a trickling filter under particular hydraulic and organic loading conditions. As in all biological treatment processes, nitrifying microorganisms grow more slowly than those primarily responsible for BOD removal. Hence, under reduced loading conditions, the wastewater remains in contact with the media and biological slime for a longer period of time allowing a nitrifying population to develop. Nitrifying organisms are very susceptible to toxicants in the wastewater and can be destroyed by toxic shock loadings.

Trickling filters are widely used where the organic material (BOD) is easily degraded, such as for municipal and certain industrial wastewaters. Organic matter which is difficult to degrade biologically will pass through the system relatively unaffected. Trickling filters are capable of consistently providing adequate treatment of wastewaters where an effluent of 20-30 mg/l BOD is acceptable. If properly designed and operated, trickling filters can provide a relatively consistent and acceptable level of treatment for many municipal wastewaters.

Treatment Plant Flow Scheme

All trickling filter plants in the study area follow essentially the same flow scheme. Wastewater enters the treatment plant and flows to the grit chamber for removal of sand and other large settleable solids. Wastewater then flows to the primary clarifier where the majority of the remaining settleable and floatable solids and a portion of the BOD and suspended solids is removed by sedimentation and skimming. The primary clarifier overflow is pumped to the trickling filter, where BOD is further reduced. The trickling filter effluent is chlorinated prior to entering the secondary clarifier where biological settleable solids are removed. A portion of the trickling filter effluent is recycled to the head of the filters, prior to chlorination, while the majority of the flow is discharged from the plant as final effluent after final clarification.

Sludge from the primary clarifiers is pumped to the anaerobic sludge digester, where it is biologically reduced to a non-objectionable state. Digestion generally reduces the potential nuisance problems of sludge and makes it more amenable to dewatering and disposal. The digested sludge is pumped to drying beds before final disposal in a landfill. Digester supernatant is pumped to the head of the plant. Sludge from the secondary clarifiers is also recycled to the head of the plant.

Although there are many possible modifications to the flow scheme described above, all trickling filter plants in the study area operate as either single-stage or two-stage systems. Single-stage operation is essentially the system described above and shown in Figure 5-3, while in two-stage operation a second trickling filter and clarifier are placed in series with the first stage. The two-stage mode of operation produces a somewhat higher quality effluent and is less sensitive to fluctuations in hydraulic or organic loading.

Davis County

North Davis County Sewer District--

The North Davis County Sewer District wastewater treatment plant is a 19.0 mgd two-stage trickling filter facility constructed in 1959. Its current average flow is 10.4 mgd, which is discharged to the Great Salt Lake via an open ditch. The District serves the municipalities of Clearfield, Clinton, East Layton, Layton, Roy, Sunset, Syracuse, West Point and South Weber as well as Hill Air Force Base and some unincorporated areas of the county. Currently, the plant serves a population of 55,090 (1970 Census).

Central Davis County Sewer District--

The Central Davis County Sewer District serves the municipalities of Farmington, Kaysville, Fruit Heights and unincorporated areas as well as the Lagoon Amusement Corporation. The entire district population of

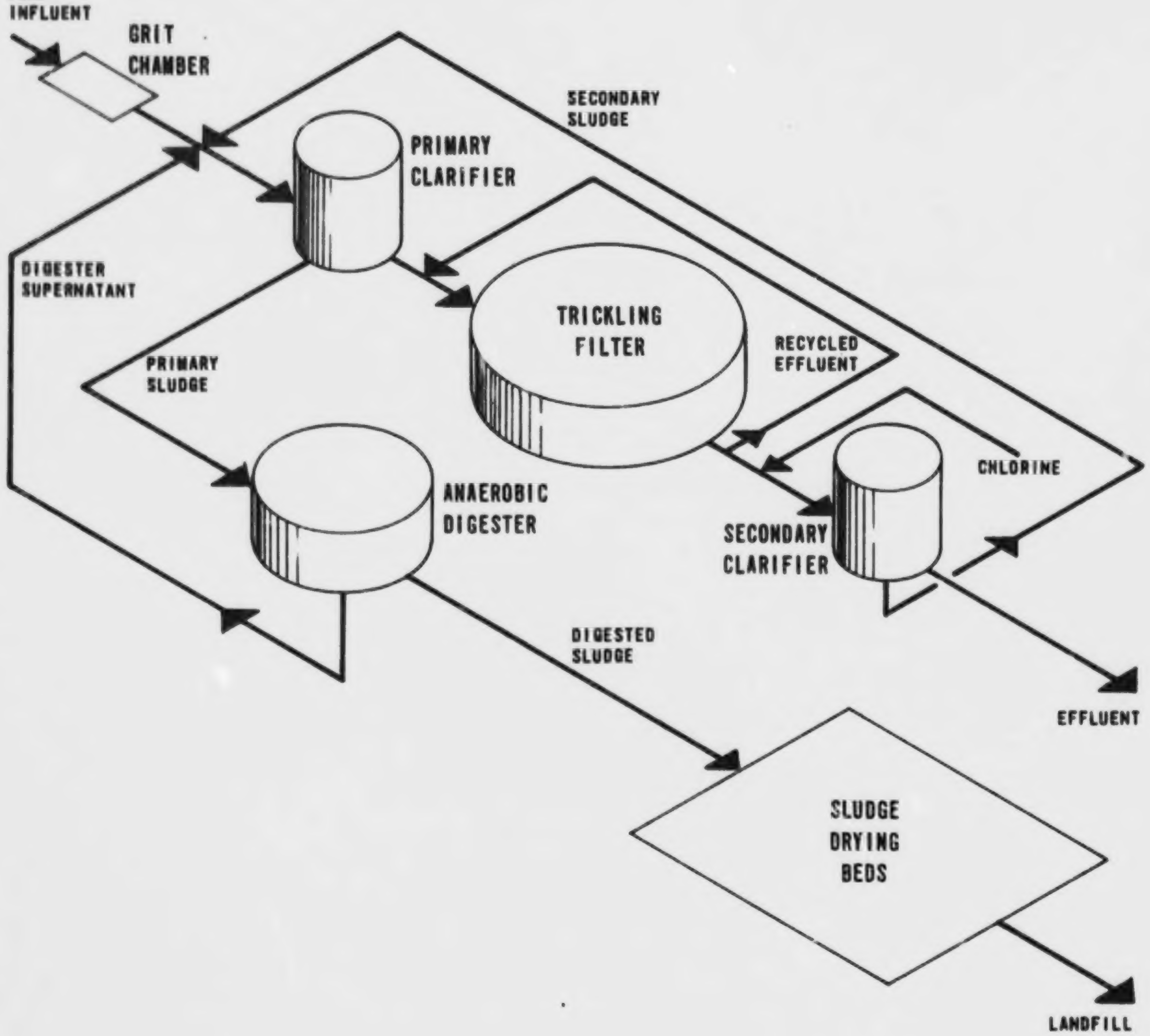

PLANT INFLUENT
GRIT CHAMBER
SECONDARY SLUDGE
PRIMARY CLARIFIER
DIGESTER SUPERNATANT
TRICKLING FILTER
RECYCLED EFFLUENT
PRIMARY SLUDGE
CHLORINE
ANAEROBIC DIGESTER
SECONDARY CLARIFIER
DIGESTED SLUDGE
EFFLUENT
SLUDGE DRYING BEDS
LANDFILL

FIGURE 5-3, TRICKLING FILTER PROCESS FLOW DIAGRAM

9,518 (1970 Census) is sewered and produces an average wastewater flow of 1.8 mgd and a peak flow of 2.2 mgd. The treatment plant is a 6.0 mgd single-stage trickling filter plant which was constructed in 1961. Effluent is discharged to the Great Salt Lake via Baer Creek.

South Davis County Sewer District

Two wastewater treatment facilities are operated by the South Davis District. The South Davis-North wastewater treatment plant is one of two trickling filter facilities constructed in the South Davis County Sewer District in 1960. The plant is a single-stage operation with a design capacity of 5.3 mgd and serves the municipalities of Centerville, West Bountiful, Woods Cross and the majority of the unincorporated areas in Planning Area C. The tributary population of 32,091 (1970 Census) results in an average wastewater flow of 4.2 mgd with a peak of 5.1 mgd. The effluent is discharged to a diversion canal from the Jordan River leading to the Farmington Bay Bird Refuge.

The second facility in the South Davis County Sewer District is the South Davis-South wastewater treatment plant. This plant serves the 13,143 people of North Salt Lake (1970 Census) and Bountiful. Bountiful is also partially tributary to the South Davis-North plant. Current design capacity of this two-stage trickling filter plant is 2.3 mgd and wastewater flow averages 1.4 mgd with a peak flow of 1.5 mgd, discharging to the Jordan River.

Salt Lake County

Magna Water and Sewer Improvement District--

The Magna Water and Sewer Improvement District comprises Planning Area D and serves the city of Magna's population of 9,992 (1970 Census). Total city population is sewered yielding a wastewater flow averaging 1.0 mgd with a peak of 1.2 mgd. The Magna treatment plant, built in 1962, is a single-stage trickling filter with a design capacity of 1.3 mgd. Effluent is discharged to Kersey Creek.

Salt Lake City--

Planning Area E, including Salt Lake City, with a population of 174,870 (1970 Census) is served by the Salt Lake City Water Reclamation plant located several miles northwest of the city. Prior to 1910 wastewater was treated at a sewage farm close to the present treatment plant; from 1910 until 1965 when the existing plant was commissioned, wastewater was discharged untreated to the Great Salt Lake via the sewage canal. Wastewater generated in the district flows to the Salt Lake City treatment plant at an average rate of 33.4 mgd with a peak rate of 35.8 mgd. The plant is a two-stage trickling filter facility with a design capacity of 45 mgd and is the largest municipal plant in the study area. Effluent is discharged to a sewage canal leading to the Great Salt Lake.

South Salt Lake--

The South Salt Lake City wastewater treatment plant was constructed in 1954 as a two-stage trickling filter facility. This plant is located in Planning Area F and serves a totally sewered population of 11,821 (1970 Census) in South Salt Lake City and the Chesterfield Sewer Improvement District. Current design capacity is 4.5 mgd and flow averages 3.7 mgd with a peak rate of 4.3 mgd. Effluent is discharged to the Jordan River.

Salt Lake City Suburban Sanitary District No. 1--

The Salt Lake City Suburban Sanitary District No. 1 serves a sewered population of 105,184 (1970 Census). Planning Areas F and G encompass Salt Lake City Suburban Sanitary District No. 1 and the Taylorsville-Bennion Improvement District, respectively, which are serviced by the treatment facility. The treatment plant was built in 1955 and is a single-stage trickling filter facility with a design capacity of 16.0 mgd. Disinfection is accomplished in a separate chlorine contact chamber downstream of the final clarifiers. Wastewater flow averages 11.7 mgd with a peak of 14.0 mgd. The effluent is discharged to the Jordan River via the Vitro storm drain.

Granger-Hunter Improvement District--

The population of the Granger-Hunter and Kearns Improvement Districts is served by the Granger-Hunter Improvement District wastewater treatment plant. The 14,374 people (1970 Census) in this district of Planning Area F are sewered and generate an average wastewater flow of 6.1 mgd and a peak flow of 6.7 mgd. Design capacity of the two-stage trickling filter plant which was built in 1959, is 7.3 mgd. Clarified trickling filter effluent is recirculated to the filter inlet in each stage and the final effluent is discharged to the Jordan River.

Salt Lake County-Cottonwood Sanitary District--

The Salt Lake County-Cottonwood Sanitary District lies in Planning Area G and serves a sewered population of 34,416 (1970 Census) from the District and from Salt Lake County Service Area #3, Snowbird. The plant was built in 1958 as a single-stage trickling filter facility. Current plant design capacity is 8.0 mgd. The flow to the plant averages 5.3 mgd with a peak flow of 5.9 mgd, final discharge is to Big Cottonwood Creek just above its confluence with the Jordan River.

Murray City--

Murray City, located in Planning Area G, has a population of 21,308 (1970 Census) and is served by a single-stage trickling filter plant. The City-owned facility was built in 1953 and has a current design capacity of 4.0 mgd. Wastewater flow averages 2.4 mgd with a peak of 4.3. The secondary effluent is discharged to the Jordan River.

Tri-Community--

The Tri-Community wastewater treatment plant serves a sewered population of 19,975 (1970 Census) in the communities of Midvale and West Jordan, and Salt Lake City Suburban Sanitary District No. 2 in Planning Area H. The plant is a single-stage trickling filter facility which was built in 1956 and at present has a design capacity of 3.8 mgd. Wastewater flow averages 3.8 mgd with a peak of 5.5 mgd, discharging to the Jordan River. The currently non-sewered population of 13,763 (1970 Census) in Salt Lake County Sewerage Improvement District No. 1 will be connected to the Tri-Community plant. This includes the community of South Jordan, Riverton, Bluffdale and Draper. Wastewater flow from the Utah State Prison and Camp Williams will also go the Tri-Community Facility.

Sandy--

The Sandy wastewater treatment plant is a standard rate activated sludge facility, built in 1962 and has a current design capacity of 1.5 mgd. The plant serves a population of 12,377 (1970 Census) from Sandy City and Sandy Suburban Improvement District in Planning Area G. Wastewater flow averages 1.7 mgd with a peak of 2.1 mgd and is discharged to the Jordan River.

Lark--

The Lark wastewater treatment facility is a 5-cell total containment lagoon constructed in 1954. Current design capacity is 0.1 mgd to serve a population of approximately 60. Effluent is disposed of through seepage to ground water and by solar evaporation.

Copperton--

The domestic wastewater from Copperton, population approximately 70, is mixed with the liquid acid wastes from the Kennecott Copper Precipitation Plant and discharged to a pond. The pond effluent is pumped back to a land disposal area above the precipitation plant and is then recycled, via wells, back through the precipitator.

Camp Williams--

Wastewater treatment facilities for Camp Williams include a primary clarifier and septic tank built in 1957. Current design capacity is not available but wastewater flow is estimated to be approximately 0.4 mgd during summer encampments. The facility is scheduled to be phased out in 1975 and the flow piped to the Tri-Community treatment plant.

Utah State Prison--

The present flow at this facility is 0.3 mgd. As per Camp Williams, the wastewater flow will be carried to the Tri-Community treatment plant starting in 1975.

Utah County

Lehi City--

The Lehi City wastewater treatment plant is a single-stage trickling filter facility constructed in 1957. Its current design capacity is 0.5 mgd and serves the 5,404 people of Lehi in Planning Area 1 (1971 UVATS). Wastewater flow averages 0.7 mgd with a peak of 0.9 mgd. The secondary treated effluent is discharged to a ditch tributary to Utah Lake.

American Fork City--

The American Fork wastewater treatment plant serves the City of American Fork in Planning Area I. The sewered population of 8,174 (1971 UVATS) produces an average wastewater flow to the plant of 1.2 mgd and a peak flow of 2.5 mgd. Design capacity of the single-stage trickling filter plant, built in 1953, is 1.5 mgd. Effluent is discharged through an outfall line to Utah Lake. It is anticipated that Alpine, which is currently unsewered, will be connected to the American Fork Plant, increasing the total population served to 9,290 (1971 UVATS).

Pleasant Grove City--

The Pleasant Grove City wastewater treatment plant is a single-stage trickling filter facility built in 1956 with a design capacity of 1.1 mgd. It serves the 5,965 people of Pleasant Grove (1971 UVATS) in Planning Area I. Wastewater flow averages 1.1 mgd with a peak of 1.3 mgd which, after treatment, is discharged to Utah Lake via a ditch.

Orem City--

Wastewater from the City of Orem in Planning Area I averages 3.2 mgd with a peak of 3.4 mgd and is treated at the Orem City Wastewater Treatment Plant. The plant is a single-stage trickling filter plant which was constructed in 1959 with a design capacity of 5.6 mgd. Effluent is discharged to a ditch flowing to a marshy area at the edge of Utah Lake. Currently, the population served is the 28,399 people of Orem (1971 UVATS). It is anticipated that the unsewered population of Lindon, 1,734 (1971 UVATS), will be connected to the Orem City facility.

Provo City--

The Provo City wastewater treatment plant is a single-stage trickling filter which was constructed in 1956 and has a current design capacity of 12.0 mgd. The plant serves Provo's sewered population of 56,287 people (1971 UVATS) in Planning Area L; there is an unsewered population of 3,539 (1971 UVATS). Wastewater flow to the plant averages 13.5 mgd with a peak rate of 16.2 mgd. Plant effluent is discharged to Mill Race, a tributary of Provo Bay.

Springville City--

The Springville City wastewater treatment plant serves the sewered population of Planning Area M, 9,314 people (1971 UVATS). The plant is a single-stage trickling filter facility constructed in 1956 with a current design capacity of 2.5 mgd. Wastewater flow averages 2.3 mgd with a peak of 3.0 mgd and is discharged to Spring Creek. It is anticipated that future treatment plans will provide for the treatment of wastewater from the unsewered population of Planning Area M, 2,846 people (1971 UVATS).

Spanish Fork City--

The Spanish Fork City wastewater treatment plant is a single-stage trickling filter facility which was constructed in 1959 and has a current design capacity of 1.8 mgd. The plant serves the 7,762 people of the city of Spanish Fork (1971 UVATS), while 1,239 people in Planning Area N-east are unsewered. Wastewater flow averages 2.4 mgd with a peak rate of 2.7 mgd and is discharged to Dry Creek, a tributary of Provo Bay.

Salem City--

The City of Salem constructed their single-stage trickling filter wastewater treatment facility in 1964. The facility has a design capacity of 0.2 mgd with present flows averaging 0.14 mgd and peak flows at 0.15 mgd. The treated secondary effluent is discharged to Beer Creek, a tributary to Utah Lake.

Payson City--

The Payson City wastewater treatment plant serves a population of 4,860 (1971 UVATS) in Planning Area N-west. The plant is a two-stage trickling filter facility which was constructed in 1968 and has a current design capacity of 1.2 mgd. Wastewater flow through the plant averages 0.5 mgd with a peak rate of 0.8 and is discharged to Beer Creek.

Wasatch County

Heber City--

The Heber City wastewater treatment plant is a single-stage trickling filter facility which was constructed on 1954 and has a current design capacity of 1.5 mgd. Although the plant only serves the Heber City population of 3,245 (1970 Mountain Area Planners) in Planning Area J, wastewater flow averages 2.6 mgd with a peak rate of 6.1 mgd because of extremely high infiltration. Plant effluent is discharged to Spring Creek.

Midway Sanitation District--

The Midway Sanitation District Wastewater Treatment Plant is also located in Planning Area J. Its tributary population is 804 (1970 Mountain Area Planners) resulting in an average wastewater flow of 0.2 mgd and a peak rate of 0.3 mgd. The plant is a single-stage trickling filter facility which was constucted in 1969 and has a current design capacity of 0.3 mgd. Effluent from the plant is discharged to Snake Creek.

Juab County

Nephi City--

The Nephi City wastewater treatment facility consists of a five-cell total containment lagoon which was constructed in 1968. The lagoon has a current design capacity of 0.3 mgd. The population of Nephi City is 2,740 (1971 UVATS) and the estimated wastewater flow is 0.2 mgd.

EXISTING INDUSTRIAL WASTEWATER TREATMENT FACILITIES

All data for discrete industrial dischargers were obtained from the Department of the Army, Corps of Engineers (COE) Application for Permit to Discharge or Work in Navigable Waters and Their Tributaries and from interviews with the dischargers. Much of the information summarized on the application forms was initially obtained from the State Division of Health files. While this form was intended to provide a comprehensive picture of each individual discharge, some data were not reported. Many analyses were conducted on grab samples and hence the degree to which they represent actual operating conditions is unknown. However, these are the most complete data available at this time (February, 1974). Effluent monitoring programs to ensure compliance with the discharge permits will provide additional data in the future. A summary of the wastewater flows and existing treatment facilities is given in Table 5-3. Locations of industrial discharges are indicated in Figure 5-4. More detailed description of each treatment facility, is given in the COE Permit Application, is presented in the following paragraphs.

TABLE 5-3

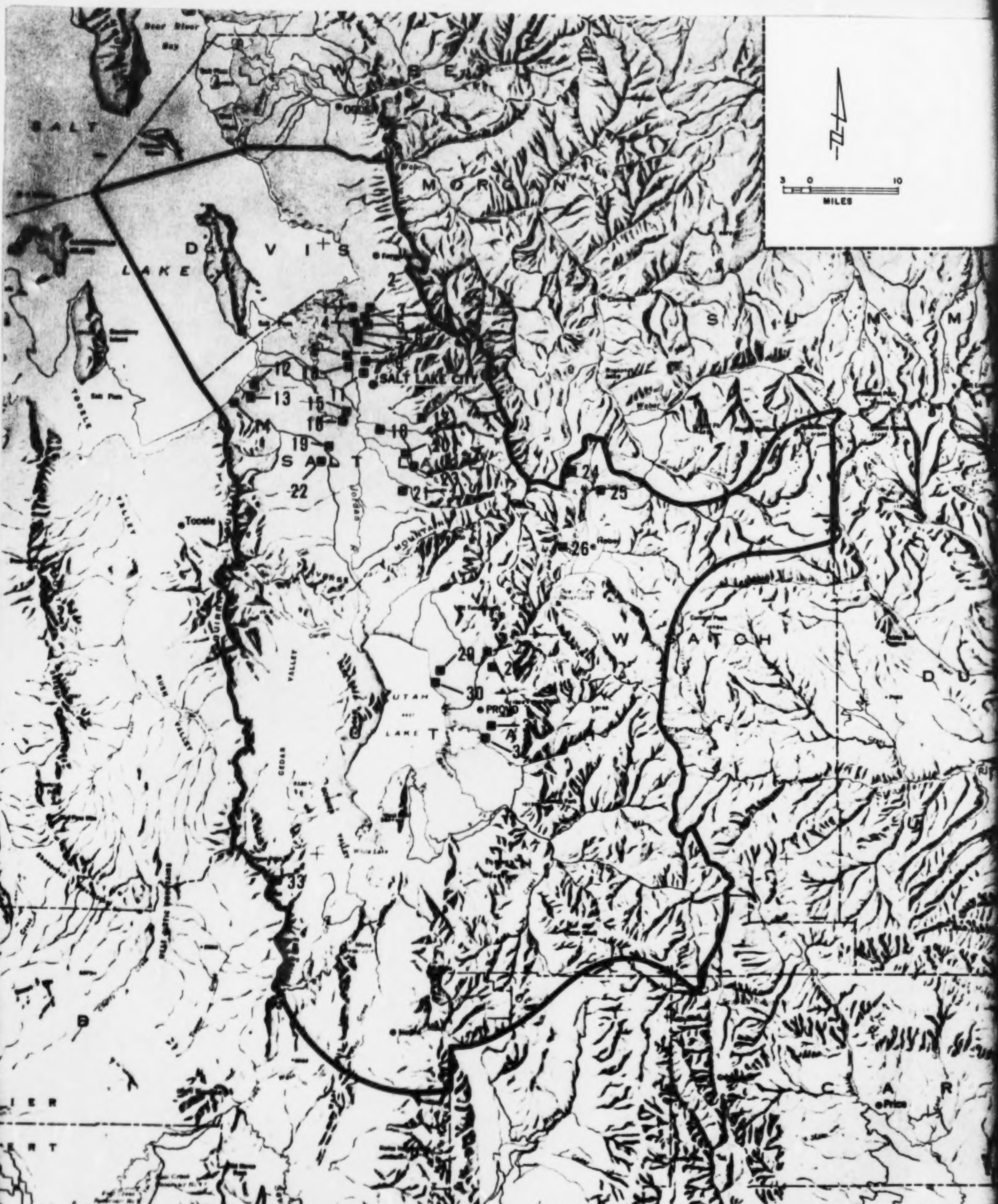
INDUSTRIAL WASTEWATER TREATMENT FACILITIES
(February 1974)

Industry SIC)	Type of Treatment	Flow, mgd	
		Avg.	Max.
Davis County			
Caribou-Four Corners (2911)	API Separators, Settling Tanks, Sour Water	0.045	0.013
Chevron Oil Co. (2911)	API Separators, Aerated Oxidation Ponds	2.16	5.04
Husky Oil Co. (2911)	API Separator Settling Pond	0.03	0.05
N.S.L. Livestock (0729)	None	0.09	-
Phillips Petroleum Co. (2911) -001	API Separators, Oxidation Ponds	0.72	1.90
Crown Refining Co. (2911)	API Separators	0.42	1.08
Salt Lake County			
Concrete Products (1442)	Settling Ponds	0.50	-
IML Freightlines (421)	Sumps and Holding Tanks	0.12	
Kennecott Copper Corporation			
Concentrator (1021)	None	6.10	6.10
Tailings Ponds(1021)	Settling Ponds	19.73	19.73
Arthur Concentrator (1021)	None	6.00	6.00
Refinery (3331)	Ponds	0.39	0.39
Smelter (3331)	None	3.97	3.97
Key Industries (1442)	Settling Ponds	0.32	0.60
Metals Processing, Inc. (5091/3471)	Dilution	0.02	0.03
Morton Salt (2899) -001	None	0.08	0.10
-002	None	0.16	0.30
-003	None	0.24	0.40
-004	None	0.32	0.50
-005	None	0.40	0.60
-006	None	0.40	0.60
-007	None	0.18	0.24
-008	None	0.24	0.32

Table 5-3 (Continued)

INDUSTRIAL WASTEWATER TREATMENT FACILITIES
(February 1974)

Industry (SIC)	Type of Treatment	Flow, mgd	
		Avg.	Max.
Salt Lake County (cont.)			
Stauffer Chemical (281) -001	None	3.74	4.32
-002	Settling Lagoon	0.22	0.72
Union Pacific RR (4011)	API Separator, Coagulation, Dissolved Air Flotation	0.40	0.40
UP&L - Gadsby Plant (491)-001	None	0.32	0.65
-002	None	0.03	0.06
-003	Skimmer Tank	0.001	0.002
-004	None	0.29	0.43
-005	None	0.29	0.43
-006	None	0.008	0.05
UP&L - Jordan Plant (491)-001	None	27.0	54.0
-002	None	0.005	0.006
-003	None	0.0003	0.0003
Utah Sand & Gravel (1442)	Settling Pond	0.18	-
Varian, Inc. (3673)	Neutralization	0.17	0.17
Wasatch Chemical (281)	Underground Disposal	-	-
Utah County			
Pacific States Steel (332)	Settling Pond	0.35	-
Reilly Tar & Chemical (2815)	Settling Tanks, Straw Filter	0.26	0.28
Springville Natl. Fish Hatchery (098)	None	9.36	10.1
Springville State Fish Hatchery (098)	None	6.79	8.54
U.S. Steel-Geneva(331)-001	Settling Ponds	25.00	25.00
-002	Trickling Filter, Chlorination	0.011	0.011
UP&L - Hale Plant (491)-001	None	27.70	27.70
-002	None	0.005	0.005
-003	None	0.02	0.02
Wasatch County			
Clear View Trout Farm (098)	None	2.84	2.84
Hecla Mining (1031)	Settling Ponds	2,69	3.10
Midway Fish Hatchery (098)	None	11.20	11.81


Bear River Bay
W E B E R
Ogden
SALT
M O R G A N
D A V I S
LAKE
S U M M
SALT LAKE CITY
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UTAH LAKE
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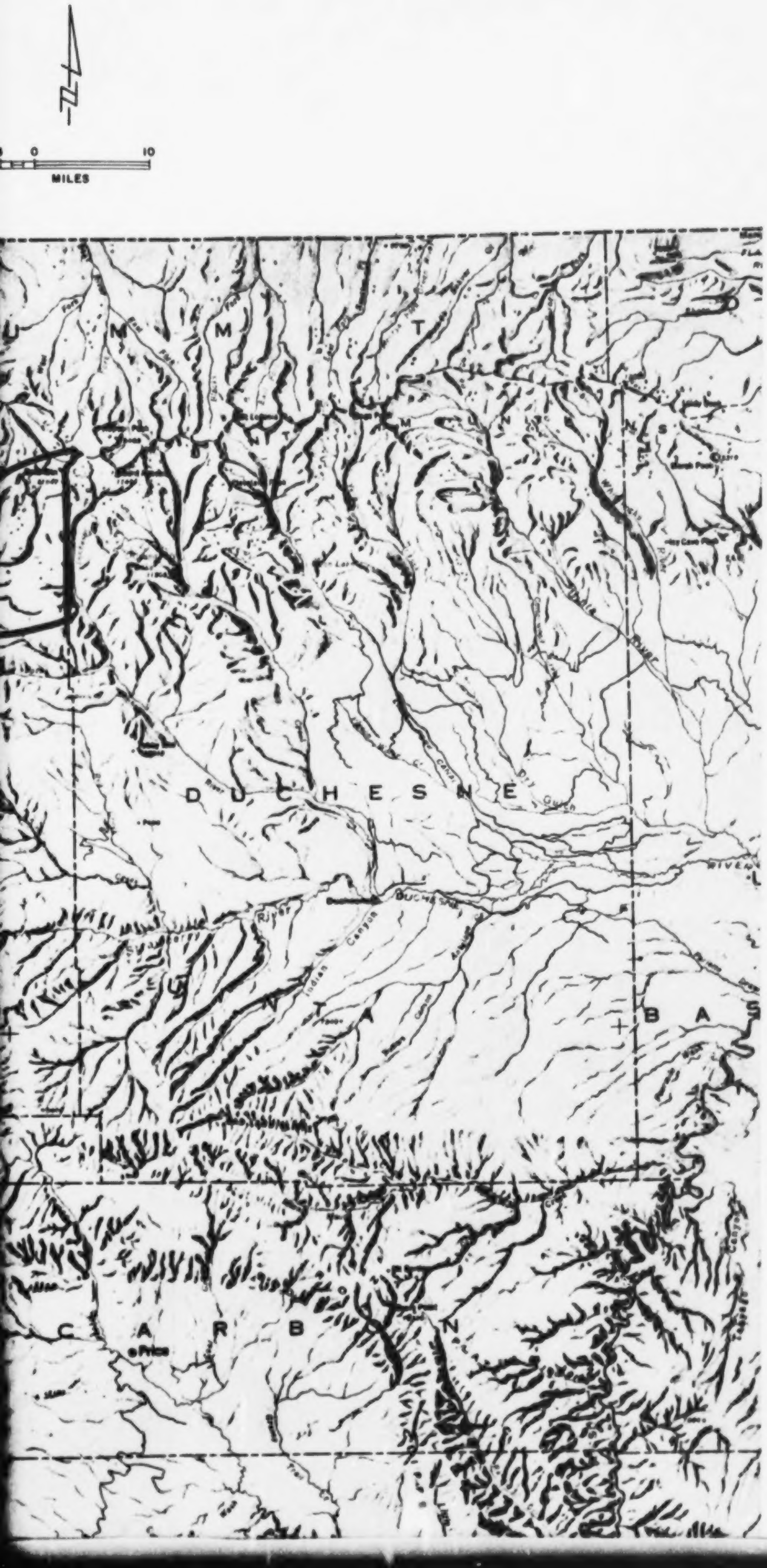

LEGEND

— STUDY AREA BOUNDARY
■ INDUSTRIES
1. CROWN REFINING CO.
2. PHILLIPS PETROLEUM CO. (3 DISCHARGES
3. CARIBOU FOUR CORNERS
4. NORTH SALT LAKE LIVESTOCK
5. PRODUCERS LIVESTOCK
6. HUSKY OIL CO.
7. CHEVRON OIL CO.
8. DENVER AND RIO GRANDE WESTERN RAILRO
9. AMERICAN OIL CO.
10. UNION PACIFIC RAILROAD
11. UTAH POWER AND LIGHT - GADSBY PLANT (6 DISCHARGES)
12. MORTON SALT
13. STAUFFER CHEMICAL CO. (2 DISCHARGES)
14. KENNECOTT COPPER CORPORATION
15. CONCRETE PRODUCTS
16. IML FREIGHT LINES
17. SALT LAKE COUNTY WATER SUPPLY - PARL
18. SCOTT AVENUE FISH HATCHERY
19. METALS PROCESSING
20. KEY INDUSTRIES
21. SALT LAKE COUNTY WATER SUPPLY - LITTLE COTTONWOOD
22. VARIAN, ASSOCIATES - EIMAC DIVISION
23. SALT LAKE COUNTY WATER SUPPLY-BIG CO
24. HECLA MINING CO.
25. CLEARVIEW TROUT FARM
26. MIDWAY FISH HATCHERY
27. UTAH POWER AND LIGHT - HALE PLANT (3 DISCHARGES)
28. REILLY TAR AND CHEMICAL CO.
29. PACIFIC STATE PIPE CO.
30. U. S. STEEL - GENEVA WORKS
31. SPRINGVILLE FISH HATCHERY
32. USDI - SPRINGVILLE
33. TINTIC MINES

FIGURE 5-4
DISCRETE INDUSTRIAL
WASTEWATER DISCHARGES

B

Davis County

Caribou-Four Corners--

This refinery processes 4,000 barrels of crude oil per day with the principal products being gasoline, No. 1 and No. 2 diesel and No. 6 fuel oil. Wastewater flow averages 8,500 gpd with a maximum of 12,700 gpd, discharging to the A-1 Drain near the City of Woods Cross. Wastewater treatment facilities include two American Petroleum Institute (A.P.I.) design separators and three settling cells in series.

Chevron Oil Company--

The Chevron refinery produces a wide range of fuel products including gasoline, diesel oil and fuel oil from a feedstock of approximately 43,000 barrels of crude oil per day. Water is drawn from the municipal supply and is used for cooling and boiler feed water. Wastewater flow which averages 1.44 mgd with a maximum of 5.04 mgd is treated prior to discharge into the Salt Lake City Sewage Canal. Treatment facilities consist of an A.P.I.-design separator followed by four ponds in series for biological oxidation. The first pond in the flow scheme is aerated with two floating surface aerators. Sanitary sewage from the refinery is segregated from the process wastewater system and is piped to the South Davis South Wastewater Treatment plant. A program is currently underway to upgrade existing treatment facilities.

Husky Oil Company

This facility is a conventional refinery which processes approximately 11,000 barrels of crude oil per day, producing gasolines, intermediate fuels and residual fuels. Ground water is the major water source and is used for cooling and boiler feed water. Wastewater treatment facilities include A.P.I.-design separators for oily wastewater and a settling pond for non-oily wastewaters. In addition, a degree of in-plant water recycling is practiced. Flow averages 29,000 gpd with a maximum of 50,000 gpd and is discharged into the Jordan River after treatment.

North Salt Lake Livestock Company--

Little information is available for this facility as the Corps of Engineers, Sacramento, California office indicated that it "was a noncritical industry and that the chemical analysis would not be necessary." Water for livestock watering is drawn from the municipal system. Wastewater flow averages approximately 90,000 gpd and the runoff from the pasture drains into a ditch in an unincorporated area of Davis County.

Phillips Petroleum Company--

The Woods Cross Refinery of Phillips Petroleum Company processes approximately 24,000 barrels of crude oil per day. Water for the plant is from ground water sources and is used primarily for cooling and process purposes. Process wastewater flow (001) averages 0.79 mgd with a maximum of 2.0 mgd. The treatment processes include A.P.I.- design separators, a surge basin, secondary skimming ponds and six ponds occupying 22 acres. Boiler blowdown flow averages 20,000 gpd with a maximum of 30,000 gpd and passes through a settling pond before it and the other pond effluents are discharged to the State Industrial Canal.

Crown Refinery Company--

This refinery in Woods Cross processes 700 barrels of crude oil per day by distillation. Well water is used for cooling, resulting in an average wastewater flow of 0.42 mgd with a maximum of 1.08 mgd. Discharge is to the A-1 Drain. This facility is currently being enlarged and a wastewater treatment system is under construction.

Salt Lake County

Concrete Products--

Concrete Products, a division of the Gibbons and Reed Company, discharges to the Salt Lake City Sewage Canal. Inlet process water is from ground water sources. Wastewater flow averages 0.5 mgd from the washing of 2,500 tons per day of sand and gravel. Concrete Products' only concern historically has been the amount of suspended solids wasted to the canal. Accordingly, a series of settling ponds, dikes and overflow weirs is the only existing wastewater treatment.

IML Freight

The truck terminal and shop for IML Freight is located in the Industrail Park area of Salt Lake City. Wastewater from this facility is generally oily municipal water, similar to that from service stations and enters in the city drain leading to the Great Salt Lake. Flow is continuous and averages 120,000 gpd. Waste oils from the IML facility are drained into holding tanks and sold. Wash racks have sumps for containment of solids and these are cleaned periodically.

Kennecott Copper Corporation

The Utah Copper Division of the Kennecott Copper Corporation constitutes one of the largest water users and wastewater dischargers in the study area. Over 95 mgd of water is drawn from surface water and ground water sources. Five individual points produce a total discharge of 38 mgd.

The first discharge (001) is from the Magna Concentrator where copper ore is processed by flotation to produce approximately 17 tons per day of molybdenite. Wastewater from the flotation process is comingled with wastewater from the cooling tower, boiler blowdown, the ash handling system of the steam generating plant, the lime plant and the sanitary sewer. The combined flow averages 8.14 mgd and is continuously discharged untreated into the C-7 ditch near the City of Magna.

Low grade copper ore is concentrated to 2,500 tons per day of 27% copper by the flotation process at the Magna and Arthur Concentrators. The waste material from this operation is a slurry which flows to a 5,300 acre tailing pond where suspended solids are permitted to settle out. An average of 36 mgd is recycled back to the process while 19.7 mgd is continuously discharged (002) to the C-7 ditch which empties into the Great Salt Lake.

Approximately 18 tons per day of molybdenite is also produced at the Arthur Concentrator facilities. Wastewater from the flotation process is comingled with the sanitary sewer flow and is discharged (003), untreated, to the C-7 ditch at an average flow of 6.9 mgd.

The Magna Refinery produces 634 tons per day of refined copper from blister copper by the electrolytic process. Wastewater is comprised of overflow from the Bosch tanks and cooling towers, spills and washdowns in the tank house, blowdown from lime softeners and boilers and spent regenerant solution from zeolite ion exchange softeners. Total wastewater flow averages 0.39 mgd and is cooled by cooling towers prior to discharge (004) to the C-7 ditch.

The Magna Smelter is primarily for the smelting of concentrated copper ore before it goes to the refinery for final purification; 780 tons of blister copper are produced daily. There are also six sulfuric acid plants at this location to convert the sulfur dioxide in the smelter gases to sulfuric acid. Once used cooling water from the smelter is reused in the flotation operations at the concentrator. Wastewater flow averages 3.2 mgd and is discharged (005) continuously from the smelter to the C-7 ditch.

A lime-precipitation system is currently being constructed to treat wastewater streams 001, 003, 004, 005.

Key Industries--

The Southeast Sand and Gravel Division of Key Industries, Incorporated produces approximately 1,500 tons per day of sand, gravel and ready-mix concrete. Groundwater is used for washing of raw bank-run gravel to the final products. Wastewater passes through two settling ponds for solids removal at an average flow of 320,000 gpd with a maximum rate of 600,000 gpd and is discharged to the Big Cottonwood Tanner Ditch.

Metals Processing--

This plant engages in two major activities: the recovery of industrial diamonds and tungsten carbide powder from new and used industrial diamond products and electroplating of copper, nickel and chrome. Sumps collect and concentrate chemical sludges for resale. All chemical wastes are diluted with fresh municipal water prior to discharge. Wastewater is discharged in batches to a city storm sewer, resulting in a total daily average flow of 240,000 gpd with a maximum rate of 280,000 gpd.

Morton Salt--

The Morton Salt Company of Saltair produces approximately 600 tons of salt by solar evaporation of 6.2 mgd of water from the Great Salt Lake. Approximately 2.0 mgd of the concentrated brine solution is returned to the Great Salt Lake via eight individual discharge points along Riter Drain and Lee Creek.

Stauffer Chemical--

The Fertilizer and Mining Division of Stauffer Chemical Company utilizes 700 tons of phosphate rock, 530 tons of sulfuric acid, 15 tons of ammonia and 6 million gallons of surface water to produce 200 tons of fertilizer each day. There are two wastewater discharges which empty into drainage ditches and eventually the Great Salt Lake. Discharge 001 is general sewer water containing all effluents except those from the tailings pond and the "wet process" phosphoric acid plant. Flow averages 3.7 mgd with a maximum of 4.3 mgd and is discharged untreated to the C-7 ditch. Discharge 002 averages 220,000 gpd with a maximum flow of 720,000 gpd. It passes through a settling lagoon prior to discharge to the West Ditch. A recirculation system is currently being constructed and there will be no discharge of process water when the new system is completed.

Union Pacific Railroad--

The Salt Lake City shops of the Union Pacific Railroad are responsible for the servicing, repair and maintenance of railroad equipment. Water used in this facility is drawn from the municipal system. Wastewaters are separated from sanitary wastes and are treated by A.P.I.-design separators and a dissolved air flotation system which uses chemical coagulants. The discharge, which averages 270,000 gpd with a maximum of 280,000 gpd, is carried to the Jordan River via an open ditch. Separated oil and other sludges are disposed of in an unspecified manner.

Utah Power & Light - Gadsby Plant--

The Gadsby Power Plant of Utah Power and Light Company produces 3,120 MWH/per day of electrical energy for the Greater Salt Lake City Area. Approximately 2.8 mgd is drawn from the Jordan River for use primarily as cooling water and that which is not evaporated is returned through six separate discharge points.

Discharge 001 is the combined flow from the No. 1 cooling water and the reactivator (clarifier) blowdown. Both flows are intermittent and the resultant discharge to the river averages 320,000 gpd with a peak rate of 650,000 gpd. An algicide is added to each flow within the plant but the combined flow receives no treatment prior to discharge.

Discharge 002 is blowdown water from boilers and evaporators and averages 29,000 gpd with a maximum flow of 58,000 gpd. This water receives no treatment and is discharged to the Abatement Canal which flows to the Jordan River.

Discharge 003 is a drain from heavy oil heaters in the pitch tank farm area. Flow averages 1,200 gpd with a maximum of 1,500 gpd and passes through an oil skimming tank prior to discharge to the river.

Blowdown from the No. 3 cooling tower constitutes Discharge 004 which has an average flow of 432,000 gpd. Algicide is also injected into this cooling water and the blowdown wastewater receives no treatment prior to discharge into the Abatement Canal which flows to the Jordan River.

Discharge 005 is blowdown water from Cooling Tower No. 2 which flows through the Abatement Canal to the Jordan River. This stream also has an average flow rate of 288,000 gpd with a maximum of 432,000 gpd and is chlorinated intermittently for algal control.

Wastewater from the turbine bearing cooling water system is discharged through the Abatement Canal to the Jordan River as Discharge 006. Wastewater flow averages 7,500 gpd with a maximum of 50,000 gpd and is not treated.

Utah Power and Light - Jordan Plant--

The Jordan Power Plant of Utah Power and Light Company is a fossil fuel plant which is normally on standby and used only occasionally. It has a production capacity of 290 to 360 MWH of electrical energy per day. The plant draws water at an average rate of 54 mgd from the Jordan River for use as cooling water and returns it through three individual discharge points.

Discharge 001 is from the No. 3 condenser and averages 27 mgd with a maximum flow rate of 54 mgd. This intake water to the condenser is batch/chlorinated for 5 minutes per day and proceeds untreated to the Jordan River.

Discharge 002 is from the bearing cooling water system. This water is supplied from the Salt Lake City municipal water system and is discharged to the Jordan River without treatment. Average flow rate is 4,800 gpd with a maximum of 6,000 gpd.

Discharge 003 is boiler blowdown and averages 510 gpd. This water is also discharged untreated to the Jordan River.

Utah Sand and Gravel--

The Stauffer Plant of Utah Sand and Gravel Products Corporation produces washed sand and gravel for use in ready-mix concrete. Raw sand and gravel are washed with Jordan River water to remove fines and other extraneous material. The water is routed to a surface pond for removal of settleable solids. Two-thirds of the water is recycled to the washing operations and one-third is discharged to the Jordan River at an average rate of 176,000 gpd.

Varian--

The Eimac Division of Varian Associates plant in Salt Lake City manufactures vacuum tubes. Water is obtained from the municipal water supply and is used in cooling, rinsing and cleaning operations. Neutralization of wastewater is performed "when necessary" but otherwise the wastewater is untreated. The wastewater flow averages 170,000 gpd and is discharged to a drainage ditch leading to the Great Salt Lake.

Wasatch Chemical--

Wasatch Chemical Company is a small plant, manufacturing and distributing several organic and inorganic chemicals. Process water used in the plant comes from the municipal system and is discharged to an underground disposal well. Water discharged to the drainage ditch is from storm runoff and from clean-up operations. This untreated flow is approximately 300 gpd.

Utah County

Pacific States Steel--

The Pacific States Cast Iron Pipe Company daily produces 318 tons of cast iron and ductile iron pipe, pipe fittings, water works valves and fire hydrants at the foundry and shops in the Ironton district between Provo and Springville. Plant intake water comes from Spring Creek and from the groundwater. Wastewater sources are melting cupola slag water, smoke and dust control operations and cement pipe lining slurry waste. The wastewater flows are discharged from three discrete locations. The first has chemical contaminants and has a mean discharge of 0.35 mgd; the second and third discharges contain only uncontaminated cooling water and are unmetered. All these points discharge to Spring Creek.

Reilly Tar and Chemical--

At the Ironton plant of Reilly Tar and Chemical, 60,000 gpd of coal tar is distilled into coal tar oils and residue to make electrode pitch. Water from Spring Creek is used in the plant primarily as cooling water. Wastewater is pumped to a settling tank where "oil" is recovered and then on to a second settling tank. The plant effluent averages 264,000 gpd with a maximum flow of 280,000 gpd and is discharged to Spring Creek.

Springville National Fish Hatchery--

The Utah State Division of Wildlife Resources operates two fish hatcheries near Springville, Utah. The National Fish Hatchery was formerly operated by the U. S. Department of the Interior for research purposes. The State of Utah has recently taken over operation for hatching and propagation of fish. Annual production of fish at the hatchery is 69,100 pounds. An average flow of 9.36 mgd with a maximum of 10.10 mgd is diverted from Spring Creek through the hatchery. The untreated flow is then discharged back to Spring Creek.

Springville State Fish Hatchery--

This facility, operated by the State Division of Wildlife Resources, is immediately upstream from the National Hatchery and has an annual production of 59,000 pounds. It also draws water from Spring Creek for pond and hatching trough operations. Wastewater flow, discharged untreated to Spring Creek, averages 6.79 mgd with a maximum of 8.54 mgd.

U. S. Steel--

The Geneva Works of U. S. Steel is located adjacent to Utah Lake and is an integrated mill, manufacturing 5,900 tons/day of semi-finished and finished steel products from iron ore. Intake water averages 26.5 mgd and is made up of a number of sources including surface and groundwaters. Cooling and process wastewaters from the steelmaking facilities average 25 mgd and are processed through settling ponds prior to discharge to Utah Lake. Sanitary wastes from the main facility is treated within the plant and effluent discharged to Utah Lake via Weir 8. The sanitary wastewaters from the pipe mill is treated and discharged to Lindon Hollow.

Utah Power and Light - Hale Plant--

The Hale Steam Electric Plant of Utah Power and Light Company is located in Orem and produces 320 MWH of electric energy daily. Water is drawn from the Provo River for a variety of purposes in the plant, primarily cooling, and is discharged at three points.

Discharge 001 averages 27.7 mgd and is used as once-through cooling water in the main condenser. This wastewater is discharged untreated into the Provo Bench Canal leading to the river.

Discharge 002 averages 5,000 gpd and is used as bearing cooling water in a once-through system and discharged to the Provo Bench Canal.

The third discharge (003) consists of ion exchange backwash and rinse water, boiler blowdown, evaporator blowdown and bearing cooling water. Flow averages 17,500 gpd and is discharged untreated directly into the Provo River.

Wasatch County

Clear View Trout Farm--

This privately owned trout farm in Heber City produces approximately 40,000 lbs. of trout each year. Springs on the property supply the 2.84 mgd of water which flows through the facility. About once a week, the "runs" where the trout grow are cleaned and discharged to the Provo River without treatment.

Hecla Mining--

The Mayflower mine of Hecla Mining Company mines and mills gold, lead, silver, zinc and copper ores by standard mining and ore flotation processes. Process water is supplied by ground water in the form of underground seepage in the mine. Final products are thickened and filtered; the water removed is recycled to the process. Solid wastes removed from the waste stream are returned underground to previously excavated areas. Those solids not returned underground are removed in a settling pond. Wastewater from this pond averages 2.69 mgd with a maximum of 3.10 mgd and is discharged to Mc Henry's Creek, a tributary to the Provo River.

Midway Hatchery--

This State facility engages in the hatching and propagation of 222,300 pounds of trout per year. Intake water comes from natural springs, passes through the hatchery and is discharged untreated to Snake Creek at an average flow of 11.2 mgd and a maximum flow of 11.8 mgd.

CHAPTER 6

FINANCIAL ARRANGEMENTS FOR WASTEWATER COLLECTION, TREATMENT AND DISPOSAL

The purpose of this chapter is to describe the existing arrangements for financing sewage service and to determine the availability of funds for future improvements. This information will facilitate an assessment of the financial feasibility of any of the alternative courses of action discussed later in the report.

AGENCIES RESPONSIBLE FOR SEWERAGE SERVICE

The laws of the State of Utah give authority to any county, incorporated municipality, improvement district, taxing district or other political subdivision of the state to own and operate sanitary sewer facilities. The law grants the right for such political entities to enter into long-term contracts with any other public owners for collection, treatment and disposal of sewage; to construct or otherwise acquire joint interests in sewer lines, sewage treatment and disposal facilities and sell any portion thereof to any other public owner; and provides for joint operation of any of the jointly owned facilities.

The inter-relationships between municipalities and sewerage agencies in each county are shown in Figures 6-1 through 6-4.

SOURCES OF REVENUE

Within the study area, the agencies responsible for wastewater management utilize a wide range of revenue sources to finance initial investments, system operation and maintenance and capital improvements. The major sources of revenue are sewer service charges, connection fees and property and sales assessments.

Property Tax

A maximum levy to be assessed is established by State law for each political entity. Single aggregate tax limitation for counties is outlined in Section 59-9-6.2 of the Utah Code. The maximum levy is based on assessed valuation with an allowed 16 mills per dollar in counties with more than $20 million and 18 mills for those counties with less than $20 million total assessed value. Exceptions to the maximum taxation rate

INTERRELATIONSHIPS BETWEEN MUNICIPALITIES AND SEWAGE AGENCIES IN DAVIS COUNTY

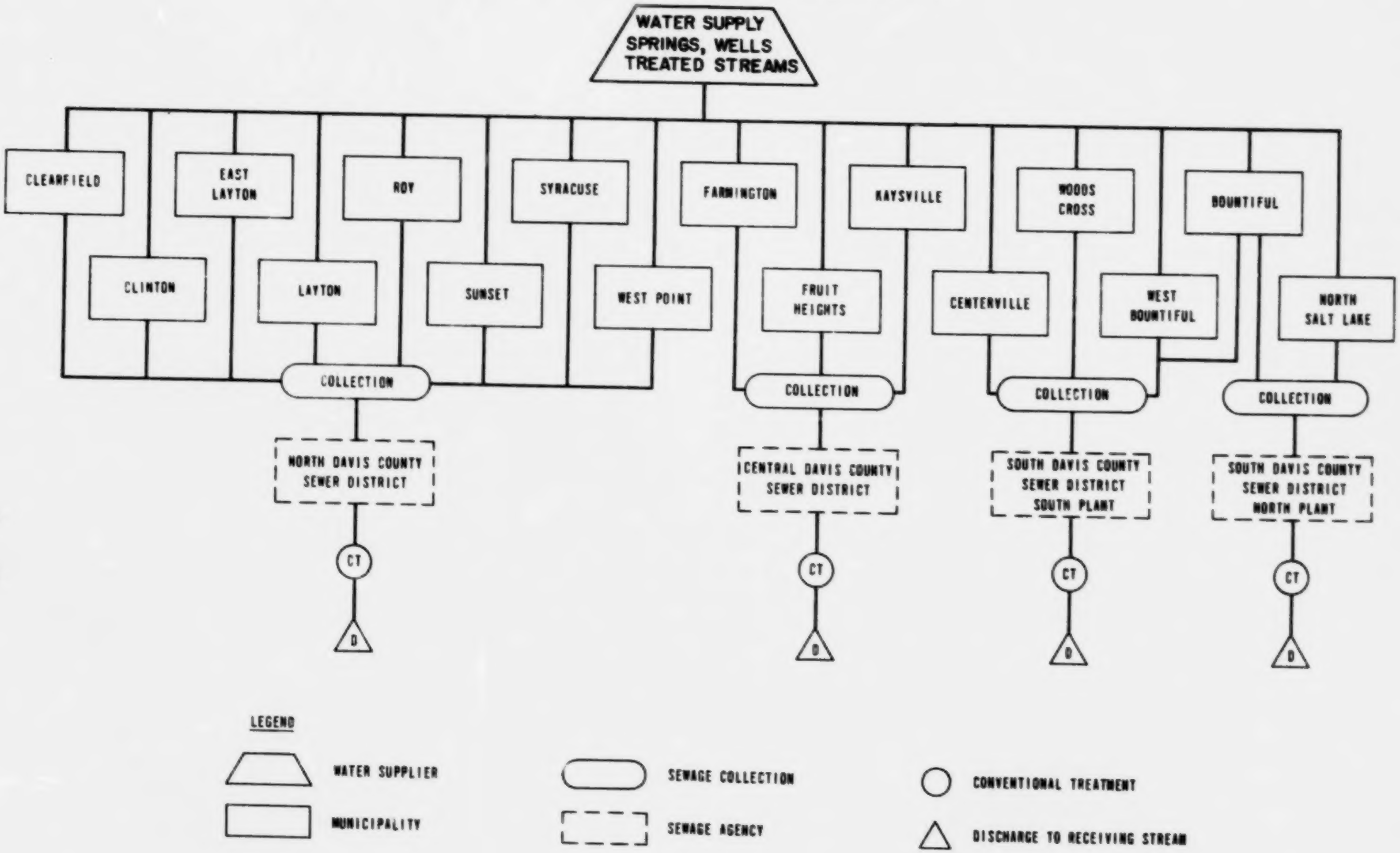
WATER SUPPLY
SPRINGS, WELLS
TREATED STREAMS
CLEARFIELD
CLINTON
EAST LAYTON
LAYTON
ROY
SUNSET
SYRACUSE
WEST POINT
FARMINGTON
FRUIT HEIGHTS
KAYSVILLE
CENTERVILLE
WOODS CROSS
WEST BOUNTIFUL
BOUNTIFUL
NORTH SALT LAKE
COLLECTION
NORTH DAVIS COUNTY SEWER DISTRICT
CT
D
COLLECTION
CENTRAL DAVIS COUNTY SEWER DISTRICT
CT
D
COLLECTION
SOUTH DAVIS COUNTY SEWER DISTRICT SOUTH PLANT
CT
D
COLLECTION
SOUTH DAVIS COUNTY SEWER DISTRICT NORTH PLANT
CT
D
LEGEND
WATER SUPPLIER
MUNICIPALITY
SEWAGE COLLECTION
SEWAGE AGENCY
CONVENTIONAL TREATMENT
DISCHARGE TO RECEIVING STREAM

FIGURE 6-1

INTERRELATIONSHIPS BETWEEN MUNICIPALITIES AND SEWER DISTRICTS IN SALT LAKE COUNTY

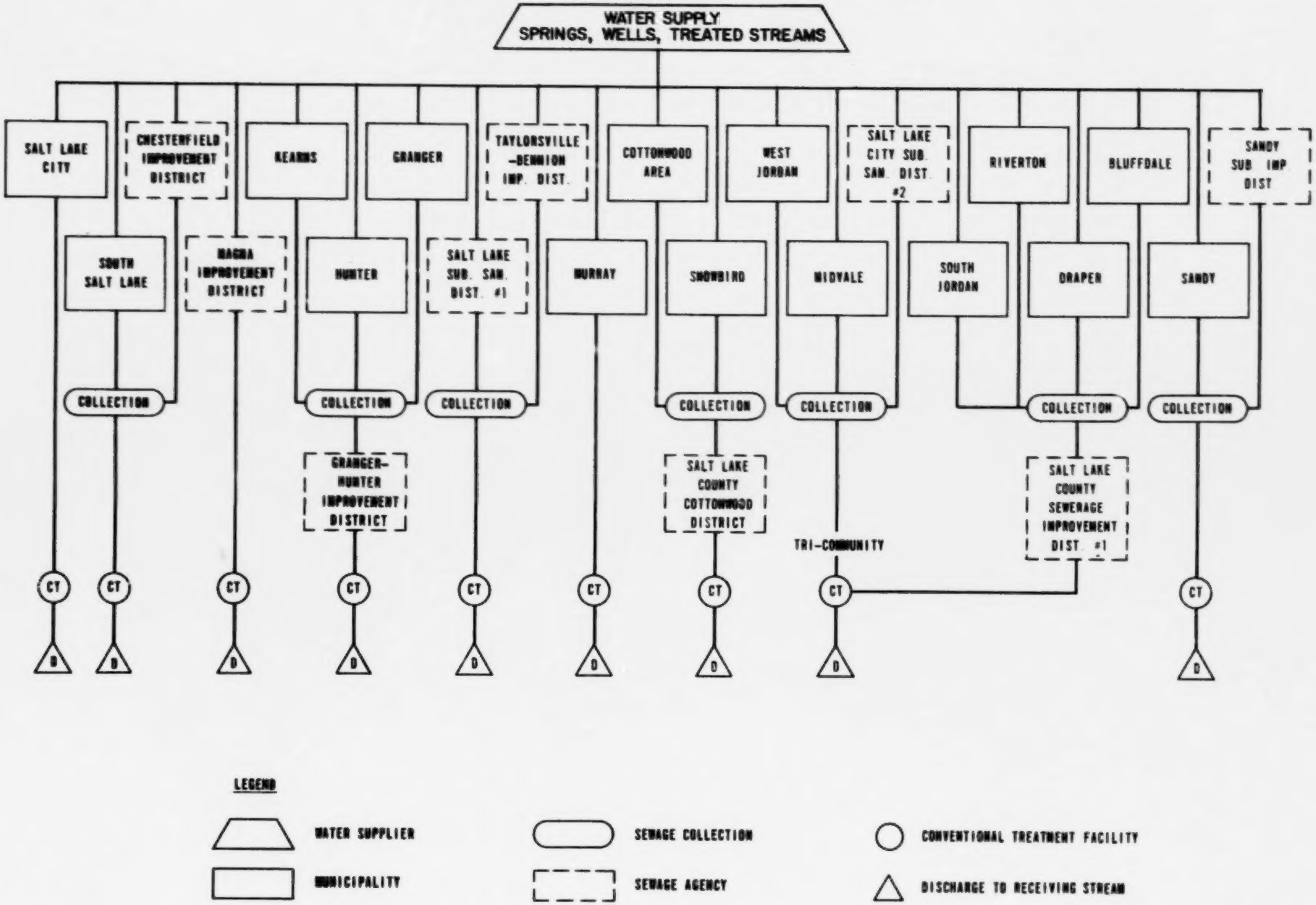
WATER SUPPLY
SPRINGS, WELLS, TREATED STREAMS
SALT LAKE CITY
CHESTERFIELD IMPROVEMENT DISTRICT
KEARNS
GRANGER
TAYLORSVILLE -BENNION IMP. DIST.
COTTONWOOD AREA
WEST JORDAN
SALT LAKE CITY SUB. SAN. DIST. #2
RIVERTON
BLUFFDALE
SANDY SUB IMP DIST
SOUTH SALT LAKE
MAGNA IMPROVEMENT DISTRICT
HUNTER
SALT LAKE SUB. SAN. DIST. #1
MURRAY
SNOWBIRD
MIDVALE
SOUTH JORDAN
DRAPER
SANDY
COLLECTION
COLLECTION
COLLECTION
COLLECTION
COLLECTION
COLLECTION
COLLECTION
GRANGER-HUNTER IMPROVEMENT DISTRICT
SALT LAKE COUNTY COTTONWOOD DISTRICT
SALT LAKE COUNTY SEWERAGE IMPROVEMENT DIST. #1
TRI-COMMUNITY
CT
D
LEGEND
WATER SUPPLIER
MUNICIPALITY
SEWAGE COLLECTION
SEWAGE AGENCY
CONVENTIONAL TREATMENT FACILITY
DISCHARGE TO RECEIVING STREAM

FIGURE 6-2

INTERRELATIONSHIPS BETWEEN MUNICIPALITIES AND SEWER DISTRICTS IN UTAH COUNTY

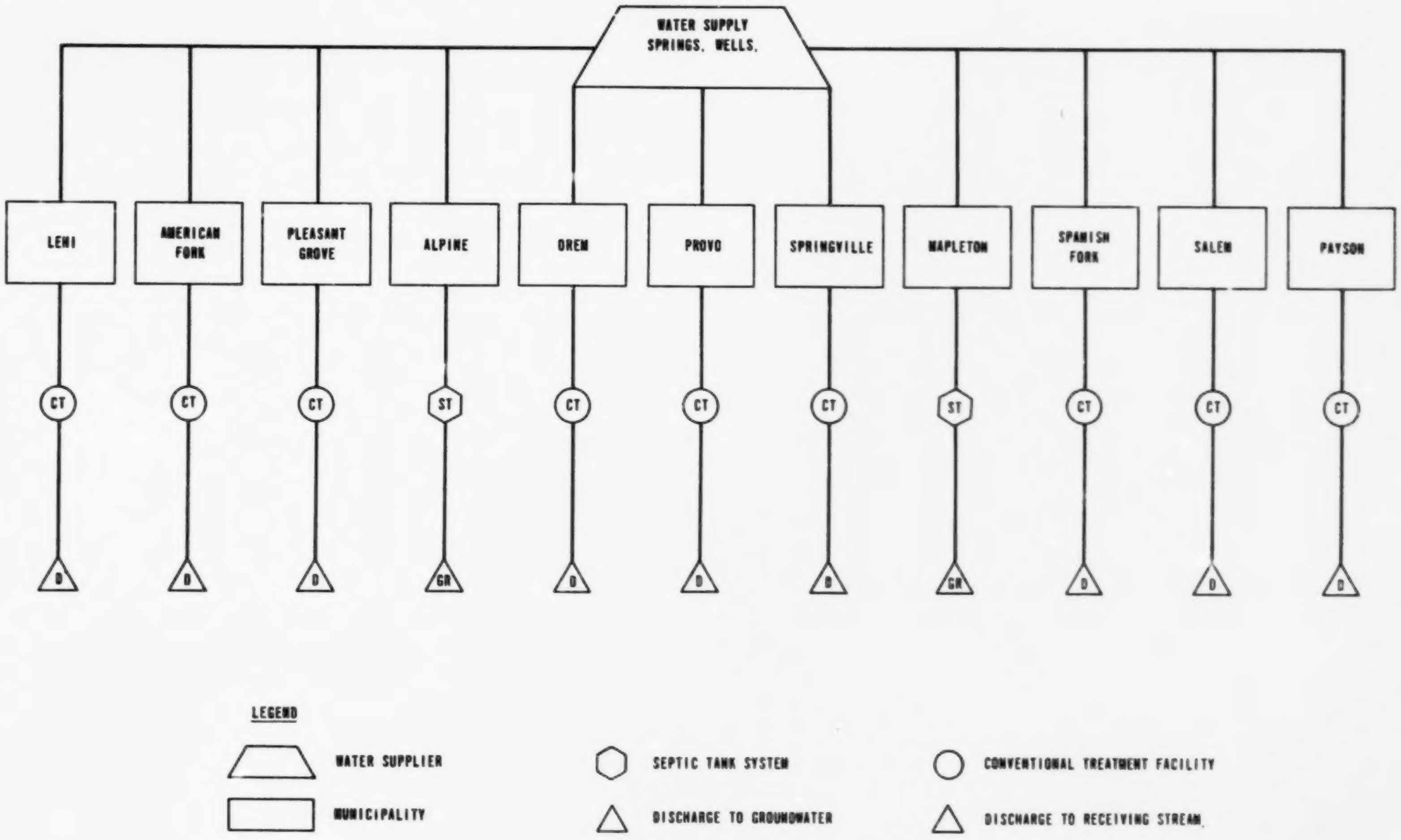
WATER SUPPLY SPRINGS, WELLS.
LEHI
AMERICAN FORK
PLEASANT GROVE
ALPINE
OREM
PROVO
SPRINGVILLE
MAPLETON
SPANISH FORK
SALEM
PAYSON
CT
ST
D
GR
LEGEND
WATER SUPPLIER
MUNICIPALITY
SEPTIC TANK SYSTEM
DISCHARGE TO GROUNDWATER
CONVENTIONAL TREATMENT FACILITY
DISCHARGE TO RECEIVING STREAM.

FIGURE 6-3

INTERRELATIONSHIPS BETWEEN MUNICIPALITIES AND SEWER DISTRICTS IN WASATCH COUNTY

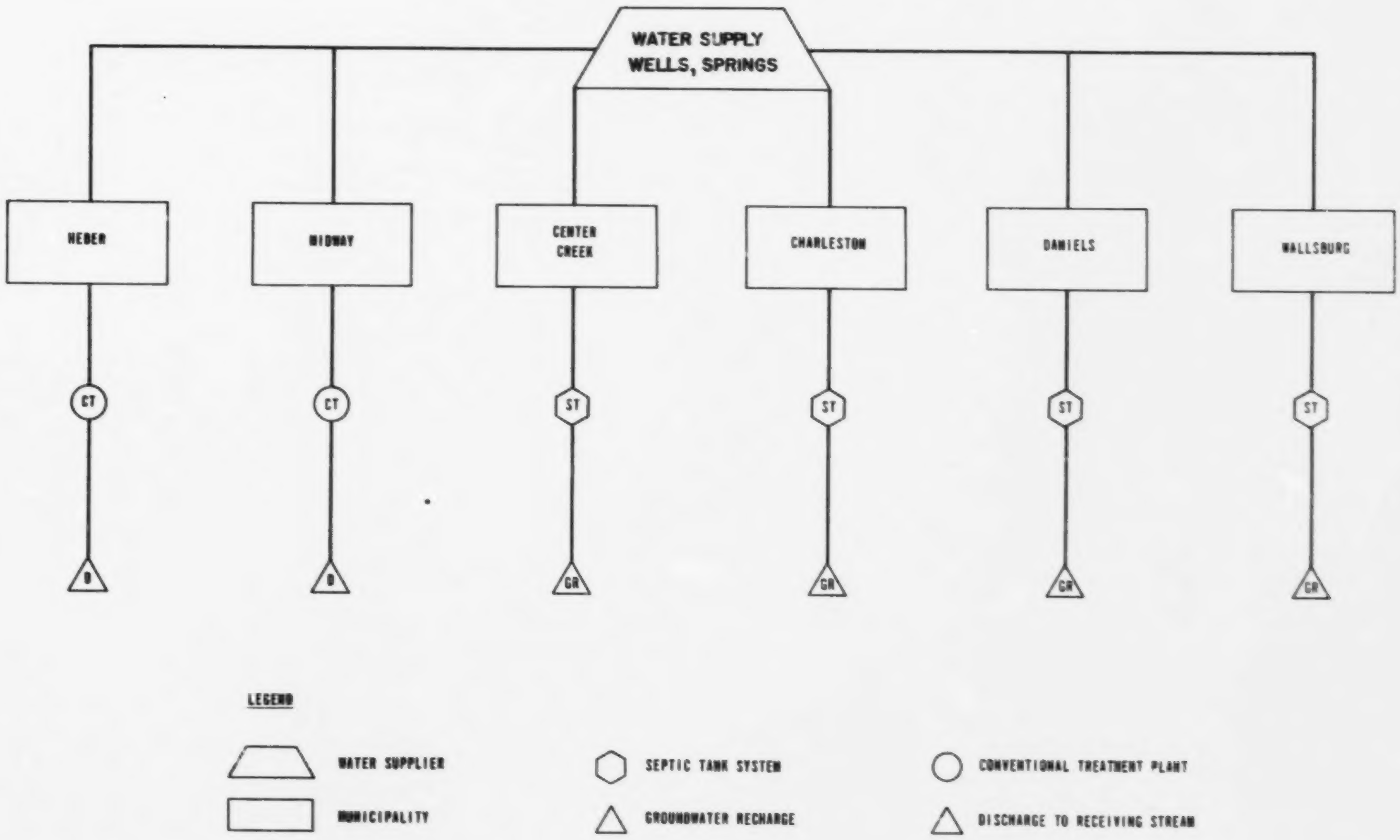
WATER SUPPLY
WELLS, SPRINGS
HEBER
MIDWAY
CENTER CREEK
CHARLESTON
DANIELS
WALLSBURG
CT
CT
ST
ST
ST
ST
D
D
GR
GR
GR
GR
LEGEND
WATER SUPPLIER
MUNICIPALITY
SEPTIC TANK SYSTEM
GROUNDWATER RECHARGE
CONVENTIONAL TREATMENT PLANT
DISCHARGE TO RECEIVING STREAM

FIGURE 6-4

are made for special services such as special improvement districts, for flood control and to pay interest and provide for a sinking fund in connection with any bonded indebtedness, including the indebtedness of county service areas and improvement districts.

Cities and towns may levy an annual tax for general operation purposes on properties that are subject to County and State taxes, provided that all taxes for such purposes shall not exceed 16 mills per dollar of assessed valuation. Exceptions to the maximum levy are made if more than two-thirds of the electors, voting in a special election called for that purpose, approve a larger levy. In no case can the tax exceed 20 mills per dollar except in the retirement of principal and interest on general obligation bonds and taxes expressly authorized to be levied in addition to the tax limit imposed.

Tax revenues secured by improvement districts can be used only to finance capital and operation and maintenance costs for wastewater collection and treatment facilities. Municipalities, on the other hand, are vested with the power to utilize taxation revenues for whatever purpose is considered necessary.

Collection of property taxes for all entities in a county, including cities and improvement districts, is the responsibility of the County Tax Commission. The taxes imposed by each entity must meet the approval of the Utah State Tax Commission prior to being imposed. The taxes collected are then allocated to the taxing entity for use as specified by the authorizing ordinance or resolution. Proceeds for cities and towns are generally placed in a general fund and are then apportioned for utility and other special fund purposes, such as retirement of general obligation bonds.

Assessed valuations of the various entities in the study area and their taxation rates (mill levies) are shown in Table 6-1. The average tax rate assessed by a sewer improvement district is 5.39 mills per dollar, while the average rate for municipalities is 17.74 mills per dollar. The range for districts varies from 1.0 mill in Salt Lake City Suburban Sanitary District No. 1 to 11.5 mills in Chesterfield Improvement District. The lowest assessment levied by a city providing sewerage collection and treatment is in West Point in Davis County, with 5.0 mills per dollar. The highest city tax rate assessed is 53.03 mills per dollar by Murray City in Salt Lake County.

TABLE 6-1

FINANCIAL ASSESSMENT OF HYDROLOGIC BASIN COUNTIES AND IMPROVEMENT DISTRICTS

ENTITY	ASSESSED VALUATION 1973	TAXATION RATE (MILL LEVY) 1973	TAXES CHARGED 1973	BONDING CAPACITY	LONG TERM GENERAL INDEBTEDNESS 1973	NET DEBT LEEWAY	REVENUE BOND INDEBTEDNESS
COUNTIES				ASS.VAL. x 3.0 x 2.0%			
Davis	$ 123,612,039	13.00	$ 1,606,957	$ 7,416,720	$ 5,750,000/3	$ 1,666,720	-0-
Salt Lake	$1,057,129,283	19.10	$20,191,179	$70,475,000	$10,000,000/3	$60,475,000	-0-
Utah	$ 198,176,913	9.50	$ 1,882,681	$11,891,000	$ -0-	$11,891,000	-0-
Wasatch	$ 18,004,646	15.74	$ 283,393	$ 1,080,000	$ 371,000	$ 709,000	-0-
Juab	$ 10,916,197	16.00	$ 174,659	$ 655,000	$ -0-	$ 655,000	-0-
IMPROVEMENT DISTRICTS				ASS. VAL. x 12% DEC. 31, 1973			
Davis County							
A. North Davis Sewer District	$ 47,151,342	2.50	$152,314	$ 7,311,000	$2,760,000/3	$ 4,551,000	$ 625,000
B. Central Davis Sewer District	12,298,428	5.00	52,739	1,476,000	510,000	966,000	335,000
C. South Davis Sewer District	63,234,479	5.70	309,662	7,588,000	2,385,000/3	5,203,000	1,295,000
COUNTY TOTAL	$122,684,249		$514,715	$16,375,000	$6,280,000	$10,095,000	$2,225,000
Salt Lake County							
D. Magna Water & Sewer Improvement Dist.	$ 8,342,651	8.00	$ 66,741	$ 1,001,000	$ 247,000/3	$ 754,000	$ 1,229,000
F. Chesterfield Improvement Dist.	2,440,557	11.50	28,066	293,000	69,000/3	224,000	181,000
Granger-Hunter Improvement Dist.	50,678,258	8.00	405,426	6,081,000	1,008,000/3	5,073,000	1,805,000
Kearns Improvement District	12,564,350	6.20	77,899	1,508,000	477,000/3*	1,031,000	475,000
Salt Lake City Sub. San. Dist. #1	145,859,851	1.00	145,860	17,503,000	1,555,000/3	15,948,000	2,244,000
G. Salt Lake County Cottonwood San.Dist.	56,562,936	5.00	282,815	6,788,000	755,000/3	6,033,000	645,000
Little Cottonwood Improvement Dist.	1,322,630	-0-	-0-	158,000	-0-	158,000	-0-
Taylorsville-Bennion Improvement Dist.	17,829,417	6.00	106,977	2,140,000	415,000	1,736,000	344,000
H. Salt Lake City Sub. San. District #2	15,110,462	3.00	45,831	1,813,000	-0-	41,813,000	281,000
Salt Lake County Sewerage Imp.Dist.#1	15,951,310	9.00	143,562	1,914,000	1,565,000	349,000	2,335,000
Sandy Suburban Improvement Dist.	14,657,898	5.80	85,016	1,759,000	448,000**	1,528,000	844,000
COUNTY TOTAL	$341,320,320		$1,387,693	$40,958,000	$6,109,000	$34,849,000	$10,383,000
Wasatch County							
J. Midway Sanitation District	$1,154,516	4.84	$5,588	$139,000	$53,000	$84,000	$183,000
COUNTY TOTAL	$1,154,516		$5,588	$139,000	$53,000	$84,000	$183,000
SERVICE AREAS				ASS.VAL. x 3.0 x 2% DEC. 31, 1973			
Salt Lake County							
G. Salt Lake County Service Area #1	$12,564,350	5.00	$ 62,822	$ 837,000	$ -0-	$ 837,000	-0-
Salt Lake County Service Area #2	21,410,141	9.00	107,051	1,426,000	585,000	841,000	-0-
Salt Lake County Service Area #3	2,196,103	5.00	10,981	146,000	-0-	146,000	-0-
COUNTY TOTAL	$36,170,594		$180,854	$2,409,000	$585,000	$1,824,000	-0-

* Kearns Improvement District General Indebtedness includes $217,000 Contract with Granger-Hunter Imp. District

** Includes $217,000 for Contract on Plant Facilities

NA Not Available

Source: 1. Utah State Auditor, Annual Audit Reports
2. Utah Foundation, Statistical Review of Government in Utah, 1974

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TABLE 6-1 (continued)

FINANCIAL ASSESSMENT OF HYDROLOGIC BASIN MUNICIPALITIES

	ENTITY	ASSESSED VALUATION	TAXATION RATE (MILL LEVY)	TAXES CHARGED 1973	BONDING CAPACITY	LONG-TERM GENERAL INDEBTEDNESS 1973	NET DEBT LEEWAY	REVENUE BOND INDEBTEDNESS
	CITIES	1973	1973			June 30, 1973		
	Davis County							
A.	Clearfield City	$ 14,195,459	17.00	$ 241,323	$ 5,678,000	$ 340,000/3	$ 5,338,000	$ 39,000
	Clinton City	2,647,954	18.25	48,325	1,059,000	556,291/3	503,000	-0-
	East Layton City	950,945	11.00	10,460	380,000	180,000	200,000	-0-
	Layton City	14,956,802	23.50	351 485	5,983,000	245,000/3	5,738,000	-0-
	Roy City	15,220,225	20.76	315,972	6,038,000	1,612,000/3	4,476,000	40,000
	Sunset City	4,969,742	22.00	109,324	1,988,000	100,000/3	1,888,000	-0-
	Syracuse City	2,793,797	9.00	25,144	1,118,000	429,000/3	689,000	-0-
	West Point City	1,220,190	5.00	6,101	488,000	35,000/3	453,000	-0-
	TOTAL	$ 56,955,114		$ 1,108,144	$22,782,000	$ 3,490,291	$19,285,000	$ 79,000
B.	Farmington City	$ 3,736,317	20.41	$ 66,053	$ 1,295,000	$ 185,000/3	$ 1,110,000	-0-
	Fruit Heights City	1,488,648	10.28	15,303	595,000	300,000/3	295,000	2,400
	Kaysville City	6,651,720	16.00	106,428	2,661,000	150,000/3	2,511,000	-0-
	TOTAL	$ 11,376,695		$ 187,784	$ 4,551,000	$ 635,000	$ 3,916,000	$ 2,400
C.	Centerville City	4,908,320	20.00	98,166	1,963,000	544,450/3	1,419,000	20,000
	Woods Cross City	3,951,052	13.00	51,364	1,580,000	123,000/3	1,457,000	36,000
	West Bountiful City	3,588,329	14.07	50,488	1,435,000	124,000/3	1,311,000	-0-
	Bountiful City	31,435,424	15.00	471,531	12,574,000	1,425,000/3	11,149,000	-0-
	North Salt Lake City	5,725,873	19.00	108,792	2,290,000	192,000/3	2,098,000	-0-
	TOTAL	$ 49,608,998		$ 780,341	$19,842,000	$ 2,408,450	$17,434,000	$ 56,000
	COUNTY TOTAL	$117,940,797		$ 2,076,269	$47,175,000	$ 6,540,741	$40,647,000	$ 137,400
	Salt Lake County							
E.	Salt Lake City	$349,997,358	27.50	$ 9,624,927	$28,000,000	$19,365,000/3	$ 8,635,000	-0-
	TOTAL	$349,997,358		$ 9,624,927	$28,000,000	$19,365,000	$ 8,635,000	-0-
F.	So. Salt Lake City	$ 22,322,095	11.50	$ 256,704	$ 8,929,000	$ 8,000/3	$ 8,921,000	-0-
	TOTAL	$ 22,322,095		$ 256,704	$ 8,929,000	$ 8,000	$ 8,921,000	-0-
G.	Murray City	$ 40,016,710	53.03	$ 2,122,086	$16,007,000	$ 2,755,000/3	$13,252,000	$ 700,000
	Alta Town	665,637	16.00	10,650	266,000	50,000/3	216,000	200,000
	TOTAL	$ 40,682,347		$ 2,132,736	$16,273,000	$ 2,805,000	$13,468,000	$ 900,000
H.	Midvale City	$ 10,451,694	20.00	$ 209,034	$ 4,181,000	$ 102,000/3	$ 4,019,000	$ 161,000
	West Jordan City	11,966,866	19.00	227,370	4,787,000	537,210/3	4,250,000	1,400,000
	Sandy City	16,225,349	19.00	308,282	6,490,000	150,000/3	6,340,000	1,150,000
	Riverton City	4,342,050	8.00	34,736	1,737,000	430,000/3	1,307,000	-0-
	South Jordan City	3,587,947	8.00	28,704	1,435,000	-0- /3	1,435,000	-0-
	TOTAL	$ 46,573,906		$ 808,126	$18,630,000	$ 1,282,823	$17,347,000	$2,711,000
	COUNTY TOTAL	$459,575,706		$12,822,493	$71,832,000	$23,410,828	$48,371,000	$3,611,000
	Utah County							
I.	Alpine City	$ 1,048,414	21.00	$ 22,017	$ 419,000	$ 142,500	$ 276,000	-0-
	American Fork City	8,761,370	19.00	166,466	3,505,000	1,301,000/3	2,204,000	44,129
	Lehi City	4,188,396	26.50	110,992	1,675,000	772,000/3	903,000	-0-
	Lindon City	1,985,282	23.00	45,361	754,000	92,000/3	662,000	-0-
	Orem City	33,886,299	23.11	783,112	13,555,000	2,475,000/3	11,080,000	525,000
	Pleasant Grove City	5,944,089	26.50	157,518	2,378,000	842,000/3	1,536,000	140,000
	TOTAL	$ 55,713,850		$ 1,283,456	$22,286,000	$ 5,722,000	$16,564,000	$ 709,129
K.	Cedar Fort Town	$ 157,948	10.00	$ 1,579	$ 63,000	-0-/3	$ 63,000	-0-
	TOTAL	$ 157,948		$ 1,579	$ 63,000	-0-	$ 63,000	-0-
L.	Provo City	$ 53,282,907	25.35	$ 1,350,722	$14,209,000	$ 4,186,000/3	$ 10,023,000	-0-
	TOTAL	$ 53,282,907		$ 1,350,722	$14,209,000	$ 4,186,000/3	$ 10,023,000	-0-
M.	Springville City	$ 8,062,564	25.00	$ 201,564	$ 3,225,000	$ 350,000/3	$ 2,875,000	-0-
	Mapleton City	2,255,948	20.30	45,796	902,000	101,027/3	801,000	-0-
	TOTAL	$ 10,318,512		$ 247,360	$ 4,127,000	$ 412,000	$ 3,725,000	-0-
N.	Spanish Fork City	$ 6,452,204	22.00	$ 141,948	$ 2,581,000	$ 575,000/3	$ 2,006,000	-0-
	Payson City	4,308,504	24.25	104,481	1,723,000	885,000/3	838,000	-0-
	Salem City	789,223	26.00	20,520	316,000	220,000/3	96,000	-0-
	TOTAL	$ 11,549,931		$ 266,949	$ 4,620,000	$ 1,680,000	$ 2,940,000	-0-
O.	Genola Town	$ 686,956	8.75	$ 6,011	$ 275,000	-0-/3	$ 275,000	-0-
	Goshen Town	370,570	8.00	2,965	148,000	65,000/3	83,000	-0-
	Santaquin City	902,170	23.00	20,750	361,000	21,000/3	340,000	-0-
	TOTAL	$ 1,959,696		$ 29,726	$ 784,000	$ 86,000	$ 698,000	-0-
	COUNTY TOTAL	$132,982,044		$ 3,175,802	$46,089,000	$12,086,000	$ 34,003,000	$ 709,129
	Juab County							
O.	Mona Town	$ 222,175	20.00	$ 4,444	$ 89,000	N.A.	N.A.	N.A.
	Nephi City	2,133,852	21.25	45,344	854,000	390,000	464,000	68,000
	COUNTY TOTAL	$ 2,356,027		$ 49,788	$ 943,000	$ 390,000	$ 464,000	$ 68,000
	Wasatch County							
J.	Charleston Town	$ 249,975	-0-	$ -0-	$ 100,000	-0-	$ 100,000	-0-
	Heber City	3,922,728	14.00	54,918	1,569,000	-0-	1,569,000	65,000
	Wallsburg Town	159,956	5.51	881	64,000	-0-/2	64,000	-0-
	Midway Town	1,154,516	4.84	5,588	462,000	48,000/3	414,000	-0-
	COUNTY TOTAL	$ 5,487,175		$ 61,386	$ 2,195,000	$ 48,000	$ 2,147,000	$ 65,000

Clearly the assessed valuation and consequently the taxes that can be charged change with time. Projections of future assessed valuations are difficult to make, although consideration of the historical data shown in Table 6-2 gives some indication of growth rate.

Sales Tax

The sales tax is intended to provide counties and municipalities of the state with an added source of revenue to meet their growing financial needs. It is the legislative intent that the added revenue be used to the greatest extent possible to finance capital outlay requirements and to service bonded indebtedness. Sales tax is collected by the State and apportioned back to the counties, cities and towns.

Connection Charges

A major source of revenue for the wastewater collection and treatment agencies is the service connection fee. The connection charge is used to recover costs incurred during construction and connection to the system.

Various methods are used to assess the connection charge. The most common method is a flat fee per residential unit. An additional charge is assessed on commercial or industrial connection. The fee is generally higher if a unit is located outside District or City boundaries. The City of Clinton in Davis County, for example, assesses $200 per connection within a subdivision, $400 within the City but not in a subdivision and $500 if the unit is outside the City limits. The average fee charged by improvement districts in the hydrologic basin is $243, while the average municipality connection fee is $187.

Connection fees and number of connections served by each entity are given in Table 6-3.

Sewer Service Charges

The sewer service charge provides the greatest source of revenue for improvement districts, while tax assessments provide the major revenue sources for municipalities. The sewer service charge is usually based on the type of user. The user categories may include residential, commercial, industrial or public institution. A wide variety of formulae are used in deriving sewer service charges. Residential charges are usually assessed at a flat rate. Charges for larger establishments may be related to

Table 6-2

ASSESSED VALUATIONS OF COUNTIES
UTAH LAKE-JORDAN RIVER HYDROLOGIC BASINS

(dollars)

Year	Davis	Salt Lake	Utah	Wasatch	Juab
1940*	15,122,005	246,272,511	42,313,009	4,048,695	7,683,847
1950	25,744,564	417,083,192	88,381,693	6,759,696	8,750,898
1955	38,206,892	568,977,261	107,670,974	6,429,497	9,291,733
1960	55,971,831	556,445,542	128,076,150	6,577,096	8,702,854
1965	74,944,090	709,499,067	144,962,631	8,262,957	9,006,842
1970	105,344,731	927,683,269	173,127,628	12,252,153	10,390,437
1971*	107,951,799	1,026,470,620	179,018,929	12,653,356	10,576,978
1972*	115,892,461	1,056,595,963	187,328,211	18,084,454	10,747,196
1973*	123,612,039	1,057,129,783	198,194,451	18,004,646	10,916,197

*Not in five-year intervals.

SOURCE: Statistical Review of Government in Utah, 1974.

TABLE 6-3
NUMBER OF SEWER CONNECTIONS, CONNECTION FEE, AND MONTHLY SERVICE CHARGE FOR CITIES AND WASTEWATER TREATMENT AGENCIES
(DECEMBER 31, 1973)

COUNTY - CITY - DISTRICT	NO. OF SEWER CONNECTIONS	CONNECTION FEE	MONTHLY SERVICE CHARGE BASE RATE
DAVIS COUNTY			
A. North Davis Sewer District	17,064	$200	$2.50
Clearfield City	2,300	$250	$2.50
Clinton City	837	$200, $400, $500 [1]	$4.00
East Layton	200	$350	$3.00
Layton City	830	$200	$4.00
Roy City	3,670	$200	$2.50
Sunset City	1,500	$150	$2.65
Syracuse City	608	$350	$3.50
West Point	242	$500	$2.50
Unincorporated Area	7,119	$200	$2.50
B. Central Davis Sewer District	2,801		
Fruit Heights City	352	$250; $350 [1]	$4.00
Kaysville City	1,755	$175	$4.00
Farmington City	633	$250	$4.00
Unincorporated Area	77	$150	$3.00
C. South Davis Sewer District	11,081	$ 50	$3.00
South Davis North Plant	7,621	$ 50	$3.00
Centerville City	1,220	$ 50	$3.00
Woods Cross City	801	$ 50	$3.00
West Bountiful City	360	$ 50	$3.00
Bountiful City	5,070	$ 50	$1.25
Unincorporated Area	170	$ 50	$3.00
South Davis South Plant	3,460		
Bountiful City	1,100	$ 50	$3.00
North Salt Lake City	710	$ 50	$3.00
Unincorporated Area	1,650	$ 50	$3.00
SALT LAKE COUNTY			
D. Magna Water & Sewer Improvement District	2,475	$150	$3.00
E. Salt Lake City Water Reclamation Plant	60,227	$ 15	$0.50 [3]
F. South Salt Lake City Sewage Plant	3,602		
South Salt Lake City	3,060	$100 + street repair	No Charge
Chesterfield Improvement District	542	$300	$4.00
Granger-Hunter Wastewater Treatment Plant	14,232		
Granger-Hunter Improvement District	10,420	$225	$3.00
Kearns Improvement District	3,812	$225	$3.00
Salt Lake Sanitary District #1 Wastewater Treatment Plant	30,194		
Salt Lake City Suburban Sanitary District #1	25,792	$225	$2.00
Taylorsville-Bennion Improvement District	4,402	$250 + $ 25 inspection fee	$6.00
G. Murray City Corporation	7,900	$150	$2.75
Salt Lake County Cottonwood Sanitary District	10,738	$200	$3.00
H. Tri-Community Wastewater Treatment Plant	7,721		
Midvale City	2,089	$150	$1.75
West Jordan	2,690	$150	$3.25
Salt Lake City Sanitary District No. 2	2,942	$150	$1.75
Salt Lake County Sewerage Improvement District No. 1 [2]	2,060	$450	$6.00
Sandy City Wastewater Treatment Plant	5,023		
Sandy City	1,526	$300	$3.00
Sandy Suburban Improvement District	3,497	$300	$3.00
UTAH COUNTY			
I. Lehi City Wastewater Treatment Plant	1,250	$250	$3.00
American Fork City Wastewater Treatment Plant	2,400	$250	$2.25
Pleasant Grove City Wastewater Treatment Plant	2,000	$250	$3.00
Orem City Wastewater Treatment Plant	5,612	$225	$2.25
L. Provo City Wastewater Treatment Plant	9,606	$100	$1.50 [3]
M. Springville City Wastewater Treatment Plant	2,695	$200	$2.50
N. Spanish Fork City Wastewater Treatment Plant	2,585	$250	$1.50
Salem City Wastewater Treatment Plant	306	$235	$3.50
Payson City Wastewater Treatment Plant	1,680	$233	$3.00
JUAB COUNTY			
O. Nephi City Wastewater Treatment Facility	977	$169	$1.75
WASATCH COUNTY			
J. Heber City Wastewater Treatment Facility	1,037	$150	$2.00
Midway Sanitation District Treatment Plant	315	$350	$4.00

[1] $200 = within subdivision
$400 = within city but not in subdivision
$500 = outside city limits

[2] Under Construction, 1974.

[3] Minimum Rate Plus Water Useage.

number of employees, number of rooms, number of plumbing fixtures or water consumption.

Monthly service charges for municipalities and improvement districts for the entire basin are shown in Table 6-3. Monthly service charges shown include only the base rate for a single residential dwelling.

FINANCING OF MAJOR CAPITAL IMPROVEMENTS

Several methods exist for financing major capital improvements such as wastewater treatment facilities, interceptors or pumping stations. Because such facilities benefit the general public, the assets of the benefitted community usually comprise the collateral for obtaining loans or issuing bonds for their financing. Similarly, because these facilities tend to benefit future populations--as well as those presently residing in the benefitted communities--repayment schedules and taxes are generally spread over the life of such facilities. Thus, the methods of financing described below tend to be generally equitable.

General Obligation Bonds

A general obligation bond is the method most widely used by public entities to finance improvements which are considered to be of general benefit to the area within the entity boundaries. The bonds are secured by and payable from taxes levied on all property within the jurisdiction of the issuing entity. General obligation bonds represent the highest type of credit that a public entity can issue and as a result are normally sold at lower interest rates than other types of bonds. The low interest rate stems from the fact that these bonds are backed by the public entity's total assets and that the interest payments are not subject to federal income tax. In most cases, the final maturity date must not exceed 40 years from the date of issuance, and the interest generally cannot exceed six percent per annum. The principal advantages of financing by issuance of general obligation bonds are the lower interest rate, the lower annual cost to meet principal and interest payments compared with other types of bonds and greater flexibility in raising funds.

Revenue Bonds

The revenue bond is another method which may be used by an entity to finance major facilities when an adequate method of levying and collecting service charges to secure payments on the bonds can be developed. Revenue bonds are distinguished from general obligation bonds in that payments of revenue bonds are secured solely by the revenues derived from the services rendered. No property taxes may be used for repayment of revenue bonds. This type of bond is becoming increasingly popular in Utah and elsewhere in the United States because of difficulties faced by many communities and public agencies in attempting to finance an increasing number of services within their general obligation bonding capacity.

There is no legal limit as to the value of a revenue bond; however, from a practical standpoint, and in order to make the bonds saleable, the principal amounts of bonds so issued should be sufficiently small so that required annual principal and interest payments are less than the revenue available for bond service. Table 6-1 includes a tabulation of the present revenue bond indebtedness for each entity.

Long-Term Contracts

A type of financing available to, but little used by, political entities to fund construction of capital improvements is a long-term contract. A long-term contract may be used by an entity in the purchase of treatment capacity or capacity in the conveyance system from a second entity. The long-term contract is a debt entered into between entities or between an entity and a financial institution (Reference 6-1). Interest rates on such loans cannot exceed eight percent per year.

Debt Limits

Each city, county, school district, improvement district, metropolitan water district, water conservancy district and county service area in the State of Utah by law has a debt limit which governs the total amount of bonded debt and tax anticipation debt that can be incurred by that municipality or other agency. For some political agencies, debt limits are set by the constitution and for some they are set by statute.

The debt limit for a county within the State of Utah is set at two percent of the reasonable fair cash value of taxable property within that county. The reasonable fair cash value is the figure from which the assessed valuation is computed at the rate of 30 percent. For example, given a 1973 assessed value figure for Salt Lake County of $1,057,129,283, the County's reasonable fair cash value would be $3,523,764,241. Two percent of this cash value is $70,475,000, which is the maximum amount of general obligation bond indebtedness that could be incurred by the county (Reference 6-2).

A different formula is used in determining the debt limit of a city in the State of Utah. First- and second-class cities are permitted to bond up to eight percent of their reasonable fair cash value. First- and second-class cities are defined by total population, first-class cities having over 100,000 and second-class having between 60,000 and 100,000 people. The debt limit is determined by calculating the reasonable fair cash value of the city and then computing the percentage allowable by State statute. The eight percent figure used for the first- and second-class cities in the State of Utah is the total debt limit available for water, sewer and lighting purposes. However, if funding is required for other purposes such as libraries, hospitals, municipal buildings and airports the debt limit is four percent of the reasonable fair cash value or one-half of the total debt limit to the extent that bonds are issued for the latter purposes.

For third-class cities in the State of Utah (those cities having less than 60,000 but more than 800 inhabitants) a total of 12 percent of the reasonable fair cash value is permitted for the maximum debt limit. The same formula for determining the reasonable fair cash value is used. Financing of libraries, hospitals, municipal buildings and airports, as well as water, sewer and lighting, are allowed from the 12 percent general obligation bonded debt limit.

For improvement districts, the debt limit is set by statute and is 12 percent of the assessed valuation of the improvement district.

Bonding Capacity and Net Debt Leeway

The maximum bonding capacity of each entity based on the debt limits described above is shown in Table 6-1. Subtracting outstanding indebtedness from bonding capacity yields "net debt leeway," a measure of the maximum amount by which each entity can incur further debt for capital expenditures. Net debt leeways, along with revenue bond indebtedness, of each entity are shown in Table 6-1.

Federal Construction Grant Program

Section 202 of the Federal Water Pollution Control Act (PL92-500) states that grants of 75 percent of the cost of construction treatment works will be made to local agencies by the federal government. Project priority, plan review, project and grant eligibility certification programs are administered by the Utah State Division of Health. The actual construction grants program is administered by the Environmental Protection Agency.

REFERENCES

6-1. "Interlocal Co-Operation Act," Ut. St. Code Annot. Chap. 13, Sec. 11-13-14, 1952.

6-2. Christensen, D., "Report to the Salt Lake County Government Study Commission," Burrows, Smith and Company, 10, 1974.

CHAPTER 7

WATER USE AND WASTE LOADS

In order to make it possible to plan alternative strategies for improving water quality in the study area it is necessary to develop a clear picture of the water quantities passing through the basins and the quality changes that occur. Man's use of the water resource for his water supply needs, and as a medium for waste disposal, is clearly an important part of this overall picture. In this chapter an estimate of the present and future water supply requirements precedes a discussion and quantification of the waste loads imposed on the waters of the basins as a result of man's activities.

Throughout this chapter two different units are used as a measure of flow rate: acre-feet per year and million gallons per day. The former unit is commonly used with respect to water supplies while the latter is used for wastewater flows. The two units are retained since they are in general use and many people can readily visualize the quantities they represent. One million gallons per day (mgd) is equal to 1,120 acre-feet per year (3.04 acre-feet per day).

PRESENT WATER USE

Water use in the Utah Lake-Jordan River Hydrologic Basins is comprised of four major readily identifiable components: municipal, industrial, agricultural and recreational water use. Present water use for each of the major user groups is summarized by county in Table 7-1 and Figure 7-1. An estimated two-thirds of the total water requirement is for agriculture. Of the remaining third, approximately one-half is used by industry. Agricultural water requirements are greatest in Utah County, while industrial and municipal demands are greatest in Salt Lake County. Use of water for recreation purposes, principally irrigation of parklands and golf courses, is mostly limited to the urbanized portion of the basins. A more detailed breakdown of water use by planning area is included in Appendix 7-A.

Municipal Water Use

Municipal water use represents the sum of urban domestic and industrial water use. Small industries and, in some cases, large industries

Table 7-1

PRESENT WATER USE (1972)

County	Water Use (acre-ft/yr)				
	Municipal	Industrial	Agricultural	Recreational	Total
Davis	29,480	2,920	127,800	5,418	165,618
Salt Lake	119,238	188,511	207,200	29,453	544,402
Utah	37,855	55,000	530,000	10,049	632,904
Wasatch	1,524	18,710	64,400	-0-	84,634
Juab	791	-0-	96,400	-0-	97,191
TOTAL	188,888	265,141	1,025,800	44,920	1,524,749

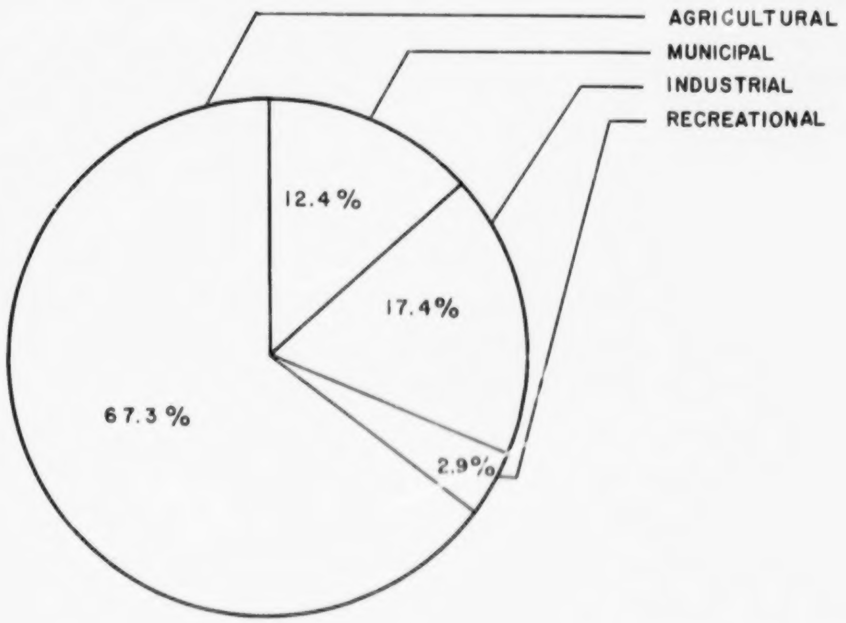

FIGURE 7-1
PRESENT WATER USE FOR
EACH MAJOR USER (1972)

located within metropolitan areas draw water from the municipal system. An analysis of industrial water use within the study area indicates that approximately 24 percent of the present municipal supply of water is used by industry.

The average rate of municipal water use in the study area is approximately 230 gallons per capita per day. Considerable variations in the rate of water use are observed from community to community and during the different seasons. The Utah County Water, Sewer and Storm Drain Study (Reference 7-1) revealed average daily per capita water use rates varying between 190 and 450 with most communities using 200 to 300 gallons per capita per day. Seasonal variation in municipal water use for several communities is illustrated in Figure 7-2. The present average daily per capita water use for Salt Lake County is reported to be 220 gallons (Reference 7-2).

Relatively high rates of domestic water usage are observed in the study area as compared to other parts of the country and are probably attributable to the extensive use of air conditioning equipment and the irrigation of lawns and gardens.

Industrial Water Use

As mentioned above, essentially all water for small industries is supplied by municipal systems, although there are a few cases where private wells are used. Major industries draw water from various sources to satisfy both process and cooling water requirements. The most common sources are surface streams and private wells or springs. A few major industries account for a relatively large portion of the total water requirement. Kennecott Copper, U.S. Steel, the three Utah Power and Light plants and the four fish hatcheries use over 86 percent of the total industrial water requirement. The information on industrial water use was obtained by personal interview and from discharge permit applications.

Agricultural Water Use

Water is used in agriculture for irrigation of crops, for livestock watering and for washdown of paddocks and buildings. The greatest volume is used for crop irrigation, which is generally practiced by flooding or furrow distribution. The demand for irrigation waters is limited to the growing season, March through October.

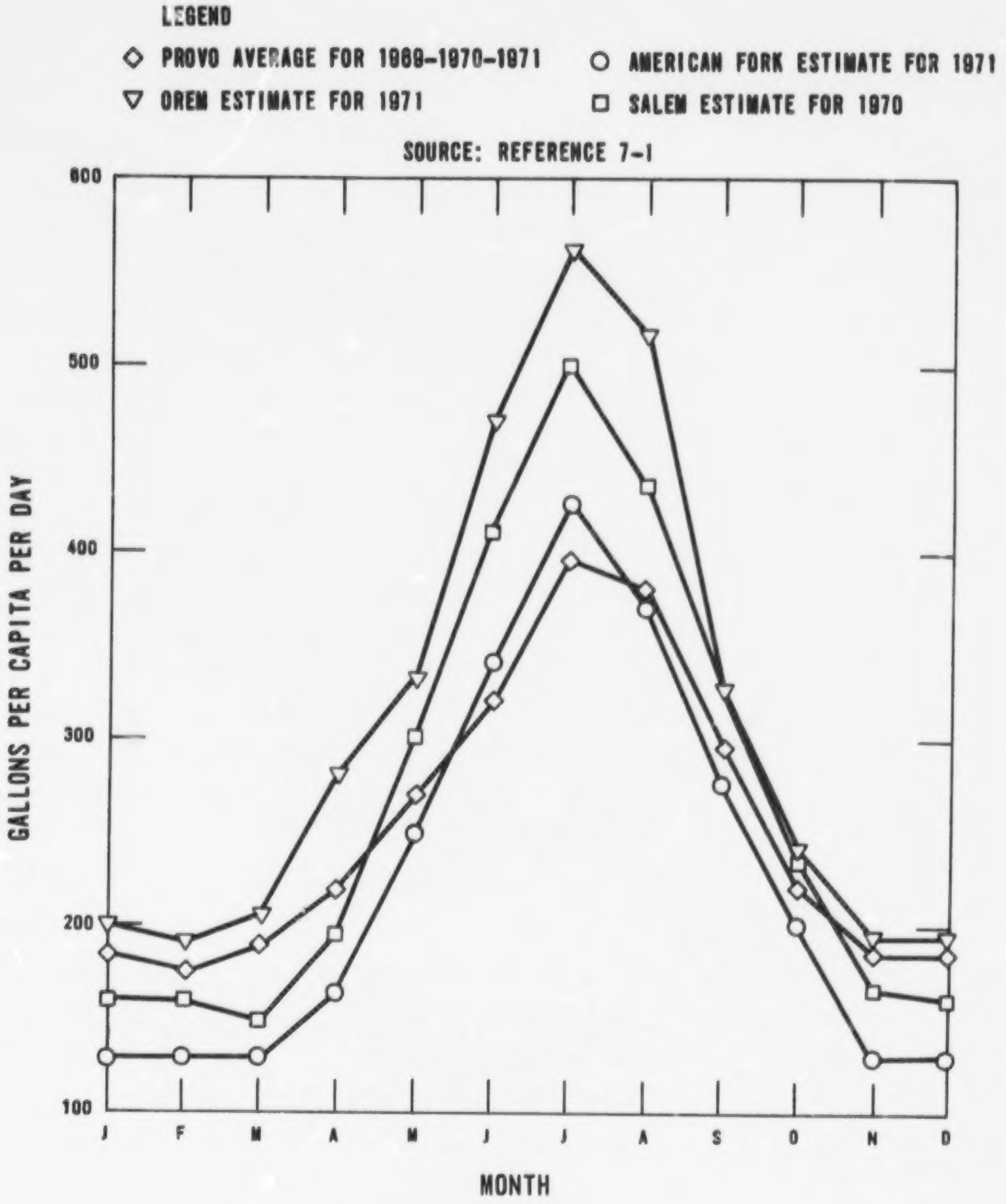

FIGURE 7-2 SEASONAL VARIATION IN PER CAPITA DAILY WATER USE IN UTAH COUNTY

Irrigation water supplies are obtained, principally, by diversion of surface streams. Diverted water is allotted by county on an "acre-foot-per-acre" basis. Water allotments in each county are four acre-feet per acre with the exception of Davis County, where the allotment is 3.5 acre-feet per acre. Since water allotments are almost always completely utilized, the existing water requirements were calculated from the total acreage of irrigated land and the total allotments.

Recreational Water Use

Water is used extensively for irrigation of recreational lands such as parks and golf courses. Water requirements were estimated from the total irrigated recreational acreage based on a 180-day irrigation season, using an average 5.4 acre-foot-per-acre water requirement. The average water requirement in the study area was determined from discussions with the staffs of local recreational facilities.

PROJECTED WATER REQUIREMENTS

Water requirement projections are necessary in that they indicate the demand that will be made on the water resources of the basin in the future and give some indication of the magnitude of future waste loads. A very considerable degree of uncertainty is inevitably involved in projections of this sort. Projected water requirements for each use category by county are shown in Table 7-2.

Projected Municipal Water Requirements

Municipal water requirements are a function of a large number of socio-economic factors, Domestic use of municipal water depends on the cost of water, population, per-capita income and life-style. Industrial use of municipal water depends on the type and level of industrial activity, the cost of water and the national economic climate. Projections of municipal water requirements were based on the population projections, assuming a small increase in per-capita water use during the study period. Based on a present average daily per-capita water use rate of 232 gallons, corresponding rates for the years 1978, 1985, and 1995 were estimated to be 241, 250, and 268 gallons, respectively.

Table 7-2

WATER USE PROJECTIONS

County	User Category	Water Use (acre-ft/yr)		
		1978	1985	1995
Davis	Municipal	43,291	52,924	72,300
	Industrial	3,145	3,418	3,794
	Agricultural	124,648	121,147	117,646
	Recreational	8,161	10,904	13,646
	Total	179,245	188,393	207,386
Salt Lake	Municipal	161,007	186,913	243,002
	Industrial	188,743	189,013	189,496
	Agricultural	195,804	186,687	173,012
	Recreational	41,822	54,191	66,561
	Total	587,376	616,804	672,071
Utah	Municipal	46,215	55,289	71,986
	Industrial	57,696	60,859	65,374
	Agricultural	522,050	514,100	504,560
	Recreational	14,255	18,460	22,666
	Total	640,216	648,708	664,586
Juab	Municipal	896	973	1,134
	Industrial	0	0	0
	Agricultural	64,400	64,400	64,400
	Recreational	0	0	0
	Total	65,296	65,373	65,534
Wasatch	Municipal	2,039	2,358	2,946
	Industrial	18,709	18,709	18,709
	Agricultural	95,147	93,894	92,640
	Recreational	0	0	0
	Total	115,895	114,961	114,295
Total Basin	Municipal	253,448	298,457	391,368
	Industrial	268,293	271,999	277,373
	Agricultural	1,002,049	980,228	952,258
	Recreational	64,238	83,555	102,873
	Total	1,588,028	1,634,239	1,723,872

Projected Industrial Water Requirements

Projections of industries' demand for water are extremely difficult to make because future industrial use depends on a number of interrelated factors, including economics, treatment technology and regulatory activities. Improvements or changes in process technology can substantially decrease water requirements per unit of product. Water recycling and reuse will be more extensively applied as improved treatment technology provides higher quality effluents and the cost of water from other sources increases. In addition, it is the policy of the U. S. Environmental Protection Agency that the volume of wastewaters generated per unit of product will be reduced by regulation during the next few years. Although it is recognized that the State of Utah's stringent interim effluent standards may discourage industrial water reuse, to some degree, the net effect of both State and Federal regulatory programs will still be to promote water reuse.

Projections of production indices for various industries in the study area have been made by EPA and HUD (Reference 7-3); however, since it is difficult to determine future water requirements per production unit, projections for the study were based on discussions with engineering or management personnel at each industrial plant.

Projected Agricultural Water Requirements

Agricultural water demand depends on the irrigated acreage, method of irrigation and types of crops grown. It is anticipated that increased urbanization in essentially all parts of the Basin will result in a net decrease in the acreage available for agriculture. The projected agricultural water requirements, presented in Table 7-2, indicate a decrease in the future, primarily as a result of urban encroachment. Shifts in types of crops produced or methods and efficiency of irrigation have been assumed to play a minor role in total water use projections.

Projected Recreational Water Requirements

Projected water requirements for recreational purposes were estimated in a similar manner to that used for estimating present recreational water use. Total acres of parks, golf courses and other recreational areas in each county were determined from estimates obtained from the Planning Departments of each county.

PRESENT WASTE LOADS

The key to analysis of water quality in the basins is a determination of the waste loads applied to the natural water bodies. For the purposes of this study, loads to the surface water and groundwater subsystems are considered separately although it is recognized that many diverse interchanges of water occur between the two subsystems.

Loads applied to the surface and groundwaters emanate from both point and non-point sources. Point or discrete sources are waste discharges that occur at a clearly defined location such as a municipal wastewater treatment plant outfall. Non-point or diffuse waste loads are those that emanate from a wide area and are applied to the water bodies at innumerable locations. Agricultural irrigation seepage, for example, may be regarded as a non-point load imposed on the groundwater subsystem.

One difficulty encountered in estimating waste loads is the need to distinguish between natural phenomena which contribute material to the water bodies and waste loads resulting from man's activities. Clearly precipitation runoff from undeveloped lands will have certain physical, chemical and biological characteristics which will affect water quality in the streams, yet this natural load cannot be considered a waste. Other instances exist where an input to a stream cannot simply be categorized as natural or man-influenced. The rational used, in the waste load estimates, for distinguishing between different kinds of inputs to the water bodies is discussed in each section of this chapter.

Waste load quantities were estimated using four key water quality constituents: biochemical oxygen demand, total dissolved solids, total phosphate and total nitrogen. In some cases, of industrial waste discharge, the concentrations of wastewater constituents other than those used in the waste load estimates are a more appropriate indicator of the pollution potential. For example, the heavy metal content of wastes from the electro-plating industry is a more significant indicator of the possible environmental impact of the waste than the biochemical oxygen demand. The four parameters were selected, however, because recognizing their limitations they still afford a simple but reliable indication of overall water quality.

The level of precision with which waste loads are estimated varies considerably since more information is available for some wastes than for others; municipal waste loads could be estimated more accurately than others since substantial municipal treatment plant effluent quality data were available. Precise estimates for the diffuse source waste loads, such as urban runoff, are inherently more difficult to make.

MUNICIPAL WASTE LOADS

Municipal wastewaters are composed of domestic and industrial wastes generated in the urban and suburban areas of the Basins. Approximately 97 percent of the wastewater is collected, treated and disposed of to the surface waters. The remainder percolates into the groundwater from septic tanks.

Basis for Estimates

Treatment plant records and the State of Utah's and EPA's water quality data bank (STORET) provided the information necessary to make the municipal waste load estimates. Flow quantities used in the calculations of present wastes were average values obtained in 1972. The average concentrations of biochemical oxygen demand, total dissolved solids, total nitrogen and total phosphate in the treatment plant effluents were calculated using the data compiled in the water quality data bank. In most cases, values for total dissolved solids, nitrogen forms and total phosphate content were measured during the last one or two years, whereas biochemical oxygen demand measurements have been made over a period as long as ten years. The older data were rejected where significant changes in treatment methods had occurred during the period of record. Inadequate data on nitrogen forms made it necessary in some cases to make estimates of total nitrogen, with reference to typical trickling filter effluents.

The municipal waste loads represent the increment in the non-water component of the water stream that results from urban use. The water used for domestic purposes initially contains certain quantities of pollutants, especially total dissolved solids and suspended solids. Initial concentrations of pollutants are subtracted from final concentrations before computation of waste loads contributed to the Basins in municipal water use. This is only logical, because in the absence of municipal use the initial pollutant loads would remain unchanged within the Basins. In the case of imported water for domestic use, on the other hand, the entire pollutant concentration of the waste stream is considered in computing waste load contributions. This distinction is necessary because, by the same reasoning used above, in the absence of municipal use the entire imported stream would remain outside the Basins.

It should be noted that the present waste loads imposed on the streams by municipal water use are a function of the existing level of applied treatment technology. Municipal wastes in the study area are almost exclusively treated by the trickling filter process. Of the four parameters studied here, only the biochemical oxygen demand of the waste stream is substantially affected by this process. Hence the mass emission rates of total dissolved solids, total nitrogen and total phosphorus represent close to the total mass emission due to urban use. Biochemical oxygen demand loading on streams represents only 10 to 20 percent of the total influent municipal mass emission rate; the remainder is removed by the treatment process and disposed of on land.

Mass Emission Rates

Mass emission rates for the four key water quality parameters from each of the municipal wastewater treatment plants in the study area are shown in Table 7-3. These data reveal that the majority of the plants are relatively small, with correspondingly low individual waste loads imposed on the surface waters of the Basin. Effluent five-day biochemical oxygen demand (BOD_5) concentrations attest to the fact that many of the secondary plants are fairly well operated and maintained and achieve adequate system performance with respect to BOD removal.

Because all of the municipal treatment plants in the study area use only conventional primary/secondary biological processes, no significant removals of nitrogen or phosphorus are obtained. In some of the low-rate

Table 7-3

UTAH LAKE-JORDAN RIVER HYDROLOGIC BASIN

MUNICIPAL WASTE LOADS

Treatment Facility	Average Flow MGD	BOD		TDS		Total Nitrogen		Total Phosphorus	
		Effl Conc mg/1	Waste Load lb/day	Effl Conc mg/1	Waste Load lb/day	Effl Conc mg/1	Waste Load lb/day	Effl Conc mg/1	Waste Load lb/day
Davis County									
North Davis County S.D.	10.4	16	1,388	503	43,576	39.1	3,387	29.8	2,582
Central Davis County S.D.	1.8	23	345	620	9,307	43.7	655	17.0	255
South Davis County S.I.D.									
North Plant	4.2	21	735	824	28,863	56.7	1,984	30.0	1,050
South Plant	1.4	27	315	1,330	15,529	36.4	424	34.9	407
Salt Lake County									
Salt Lake City	33.4	27	7,521	726	201,989	24.1	6,705	19.9	5,537
Magna Imp. Dist.	1.0	22	184	1,846	15,395	56.3	469	33.0	275
South Salt Lake City	3.7	28	864	782	24,130	23.4	721	35.4	1,091
Salt Lake City SSD #1	11.7	27	2,635	917	89,479	19.7	1,920	23.9	2,329
Granger-Hunter Imp. Dist.	6.1	30	1,526	1,113	56,623	66.5	3,379	35.0	1,778
Salt Lake Co.-Cottonwood	5.3	45	1,969	685	30,242	24.2	1,068	40.7	1,797
Murray City	2.4	31	620	788	15,773	27.0	540	27.1	542
Tri-Community	3.8	27	856	856	27,128	25.4	804	26.2	829
Utah State Prison	0.3	34	85	1,007	2,520	31.0	77	9.4	23
Camp Williams	0.4	89	297						
Sandy City	1.7	31	440	730	10,350	28.0	396	40.5	574
Lark City	0.1	45	37	431	359	41.0	34	4.0	3
Utah County									
Lehi City	0.7	26	152	347	2,023	43.4	253	23.8	139
American Fork	1.2	34	340	243	2,429	33.3	333	32.8	328
Pleasant Grove	1.1	23	211	302	2,932	45.5	455	31.8	291
Orem	3.2	30	801	327	8,716	30.1	802	32.0	853
Provo	13.5	22	2,477	479	53,866	19.3	2,170	14.5	1,631
Springville	2.3	25	480	226	4,330	29.2	559	21.6	414
Spanish Fork	2.4	24	480	423	8,457	27.2	544	27.6	552
Salem	0.1	25	21	576	480	44.4	37	14.5	12
Payson	0.5	14	58	319	1,329	48.6	202	16.1	67

Table 7-3 (Continued)

Treatment Facility	Average Flow MGD	BOD		TDS		Total Nitrogen		Total Phosphorus	
		Effl Conc mg/1	Waste Load lb/day	Effl Conc mg/1	Waste Load lb/day	Effl Conc mg/1	Waste Load lb/day	Effl Conc mg/1	Waste Load lb/day
Wasatch County									
Heber City	2.6	21	455	337	7,307	58.4	1,265	18.7	405
Midway City	0.2	8	13	722	1,204	51.8	86	14.5	24
Juab County									
Nephi City	0.3	28	70	646	1,616	14.9	37	9.3	23
Totals									
Davis County	17.8		2,783		97,275		6,450		4,294
Salt Lake County	69.9		17,034		473,988		16,113		14,778
Utah County	25.0		5,020		84,562		5,355		4,287
Wasatch County	2.8		468		8,511		1,351		429
Juab County	0.3		70		1,616		37		23
Basin Total	115.8	27.4	25,375		665,952		29,306		23,811

trickling filter plants, ammonia and organic nitrogen forms in the influent are converted to nitrate, but little total nitrogen is removed. Similarly, a small amount of phosphorus is removed by the organisms as a nutrient required for growth.

Industrial Component of Municipal Wastewaters

Many of the industries within the study area discharge wastewaters to the municipal sewer systems. In this presentation, discharges of this type are referred to as non-discrete industrial discharges to differentiate them from discharges from industry made directly to the surface waters. The non-discrete industrial dischargers generally are small industries located within the metropolitan area.

The industrial component of the municipal waste stream is of great importance, since it is less homogenous than domestic wastewaters and is the source of many environmentally damaging substances that are not present in domestic wastes. Within the study area, non-discrete industrial discharges have been characterized with respect to flow and BOD only (Reference 7-4). While this is valuable information, clearly it gives little indication of the true pollutional potential of these wastes. Other parameters of importance which should be obtained in future studies include total dissolved solids, heavy metals concentrations and hexane-extractable materials.

Proportional flow and BOD load imposed on the municipal plants by the non-discrete industrial dischargers are shown in Table 7-5. Wastewater flow due to industrial dischargers constitutes approximately five percent of the total municipal flow, while the BOD load from industrial sources represents 18 percent of the load. The importance of industry as a source of BOD is particularly significant in Salt Lake City, where 34 percent of the total BOD is attributable to industry.

An inventory of non-discrete industrial dischargers is included in Appendix 7-B.

Table 7-4

INDUSTRIAL CONTRIBUTION TO MUNICIPAL TREATMENT SYSTEMS

	Total Municipal Influent Load		Industrial Load to Municipal System	
Treatment Facility	Average Flow, mgd	BOD, lb/day	Flow, %	BOD, %
Davis County				
North Davis County S.D.	10.4	17,326	10.9	21.9
Central Davis County S.D.	1.8	2,999	5.0	35.9
South Davis County S.I.D.				
North Plant	4.2	6,997	0.0	0.0
South Plant	1.4	2,332	0.4	0.3
Salt Lake County				
Salt Lake City	33.4	55,644	6.3	33.9
Magna Improve. Dist.	1.0	1,666	NS	NS
South Salt Lake City	3.7	6,164	10.2	36.9
Salt Lake City SSD #1	11.7	19,492	0.9	8.2
Granger-Hunter Imp. Dist.	6.1	10,162	1.4	2.8
Salt Lake Co.-Cottonwood	5.3	8,830	1.3	10.1
Murray City	2.4	3,998	6.0	17.4
Tri-Community	3.8	6,331	7.2	7.1
Utah State Prison	0.3	500	3.6	12.0
Camp Williams	0.4	666	NS	NS
Sandy City	1.7	2,832	34.5	0.2
Copperton City	ND	ND	ND	ND
Lark City	0.1	167	NS	NS
Utah County				
Lehi City	0.7	1,166	NS	NS
American Fork	1.2	1,999	NS	NS
Pleasant Grove	1.1	1,833	NS	NS
Orem	3.2	5,331	3.5	20.9
Provo	13.5	22,491	8.3	15.8
Springville	2.3	3,831	0.1	4.2
Spanish Fork	2.4	3,998	1.6	4.2
Salem	0.1	167	NS	NS
Payson	0.5	833	3.8	45.5
Wasatch County				
Heber City	2.6	4,332	NS	NS
Midway City	0.2	333	NS	NS
Juab County				
Nephi City	0.3	500	NS	NS
Totals				
Davis County	17.8	29,655	6.9	16.5
Salt Lake County	69.9	116,453	4.5	21.6
Utah County	25.0	41,650	5.2	12.9
Wasatch County	2.8	4,665	NS	NS
Juab County	0.3	500	NS	NS
Basin Total	115.8	192,923	4.9	18.3

NS = no significant industry contribution
ND = no data

INDUSTRIAL WASTE LOADS

As discussed previously, wastewaters resulting from industrial activity may be discharged to a municipal sewer or directly to the surface waters. The former, non-discrete industrial discharges are characterized as part of the total municipal waste load. The focus of this section is on discrete industries, those that handle their wastes independently.

Basis for Estimates

Data for the discrete industrial dischargers were obtained from the Corps of Engineers "Application for Permit to Discharge or Work in Navigable Waters or their Tributaries." All dischargers into navigable waters were required to file this permit application under the provisions of the Refuse Act of 1899. No attempt was made to verify the information on these forms; it must be noted that reported values were often based on individual "grab" samples which may not represent "typical: operating conditions. In calculating the waste load resulting from each industrial activity, the following procedure was used: for industries whose water source is a surface water, only the incremental amount of each pollutant added was attributed to the industry; in cases where the source water was other than surface water, the total pollutant load of the wastewater stream was attributed to the industry.

Mass Emission Rates

A summary of flows and mass emissions of biochemical oxygen demand from both discrete and non-discrete industrial sources within the Basin is shown in Table 7-5. These data indicate that, in terms of wastewater flow, the volume resulting from discrete dischargers is much greater than the volume discharged to municipal systems. In terms of BOD, however, the non-discrete load is larger than the discrete load. It should be noted that the BOD discharged to the municipal systems receives secondary treatment in most cases so that the actual BOD load imposed on the surface streams by non-discrete industrial discharges is approximately 15 percent of that discharged to the sewers.

Table 7-5

INDUSTRIAL WASTE LOADS FROM DISCRETE AND NON-DISCRETE SOURCES

	Flow, mgd		BOD, lb/day	
County	Discrete	Non-Discrete	Discrete	Non-Discrete
Davis	3.58	1.28	845	4,908
Salt Lake	74.37	3.11	4,476	25,074
Utah	69.29	1.29	1,779	5,375
Wasatch	16.73	0	606	0
Total	163.97	5,68	7,706	35,357

Mass emission rates from discrete industrial sources of the four key water quality parameters are shown in Table 7-6. It is recognized that from the standpoint of potential environmental impact many different parameters must also be considered; however, for the purposes of the study, detailed consideration was limited to the four parameters. More detailed information on the characteristics of discrete industrial discharges is included in Appendix 7-C.

WASTE LOADS RESULTING FROM URBAN STORM RUNOFF

Precipitation falling on the land surface undergoes quality changes as it flows to the water courses. Salts are leached out of the soil, particulate inorganic material is eroded away by the moving water and complex organics are contributed by plants and microflora. These quality changes are part of the natural hydrologic cycle.

As the land form and its use is affected by man's activities, the nature and extent of surface runoff changes. Consequently the impac of the runoff on stream water quality is also altered. Thus a form

Table 7-6

DISCRETE INDUSTRIAL DISCHARGERS

County	Industry		SIC	Flow, gal/day	BOD		TDS		Total Nitrogen		Total Phosphorus	
					mg/l	lb/day	mg/l	lb/day	mg/l	lb/day	mg/l	lb/day
Davis	Caribou-Four Corners		2911	45,000	26	10	2,556	959	13.5	5.1	.5	0.2
	Chevron Oil		2911	2,160,000	35	630	1,300	23,419	45.2	814	18.7	337
	Husky Oil		2911	29,000	310	75	1,167	282	33.3	807	3.5	.9
	NSL Livestock		0729	90,000	-	-	-	-	-	-	-	-
	Phillips Petroleum	001	2911	720,000	18	108	1,038	6,233	9.3	56	.9	5.4
	" "	002	493	20,000	22.8	3.8	631	105	75.4	12.6	3.4	.56
	" "	003	2911	44,000	4	14.6	10	36.6	17.9	65.5	0.3	1.15
	Crown Refining		2911	420,000	1	4	850	2,975	3.8	13.3	0.16	.6
Davis County Total				3,528,000		845		34,010		1,773.5		345.8
Salt Lake	American Oil		2911	1,300,000	35	379	2,220	24,069	5.9	64	3.5	38
	Concrete Prod. (G&R)		1442	500,000	-	-	15,480	64,000	-	-	-	-
	Denver & Rio Grande RR		-	25,000	140	29	-	-	-	-	-	-
	Kennecott Copper											
	Concentrator	001	1021	6,100,000	6.7	341	3,228	164,221	4.4	234	2.5	127
	Tailing Pond	002	1021	19,730,000	4.4	724	2,376	390,966	2.1	346	1	164
	Arthur	003	1021	6,000,000	4.0	200	3,444	172,338	2.9	145	0.38	19
	Refinery	004	3331	390,000	2.8	9	3,378	10,987	5.3	17	7.8	25
	Smelter	005	3331	3,967,000	65	2,150	4,478	148,154	1.6	63	5.4	179
	Key Industries (Southeast Sand & Gravel)		1442	320,000	-	-	639	1,710	-	-	-	-
	IML Freight		421	123,000	240	246	994	1,020	19.22	20	.63	.6
	Metal Processing		5091	24,000	15	3	675	135	106.1	21	5.9	1.1

Table 7-6 (Continued)

County	Industry		SIC	Flow, gal/day	BOD		TDS		Total Nitrogen		Total Phosphorus	
					mg/l	lb/day	mg/l	lb/day	mg/l	lb/day	mg/l	lb/day
Salt Lake	Morton Salt	001	2899	80,000	-	-	-	-	-	-	-	-
		002	2899	160,000	-	-	-	-	-	-	-	-
		003	2899	240,000	-	-	-	-	-	-	-	-
		004	2899	320,000	-	-	-	-	-	-	-	-
		005	2899	400,000	-	-	-	-	-	-	-	-
		006	2899	400,000	-	-	-	-	-	-	-	-
		007	2899	180,000	-	-	-	-	-	-	-	-
		008	2899	240,000	-	-	-	-	-	-	-	-
	Scott Ave. Hatchery		098	1,228,000	4.1	42	488	5,000	4.7	48	-	-
	Stauffer Chemical	001	281	3,744,000	4	125	900	28,026	.1	3	162	5,060
		002	281	216,000	0	0	6,500	11,700	.6	1	375	675
	Union Pacific RR	001	-	400,000	45	150	1,030	3,436	7.5	25	-	-
	Utah Sand & Gravel		1442	176,000	-	-	8,502	12,458	-	-	-	-
	Utah Power & Light (Gadsby Plant)	001	491	320,000	5	13	1,370	3,645	2.7	9	-	-
		002	491	28,700	<5	-	800	192	2.4	0.6	3	.72
		003	491	1,200	<5	-	40	.4	<.65	0.0	<.12	0
		004	491	288,000	<5	-	1,755	4,194	6.8	16	20.5	49
		005	491	288,000	5	12	2,430	5,808	6.8	16	20.5	49
		006	491	7,500	<5	-	0	0	0	0	0	0
	UP&L-Jordan	001	491	27,000,000	2	45	0	0	0	0	0	0
		002	491	4,800	5	0.2	680	27	1.5	0.06	0.85	0.03
		003	491	510	<5	-	0	0	0	0	0	0

Table 7-6 (Continued)

County	Industry		SIC	Flow, gal/day	BOD		TDS		Total Nitrogen		Total Phosphorus	
					mg/l	lb/day	mg/l	lb/day	mg/l	lb/day	mg/l	lb/day
Salt Lake	Varian, Inc.		3673	170,000	5.8	8	250	352	11.2	15	0.36	0.54
	Wasatch Chemical		281	UNDERGROUND DISPOSAL								
Salt Lake County Total				74,371,710		4,476		1,052,438		1,044		6,388
Utah	Pacific States Pipe		332	148,000	5.6	7	488	600	7.8	10	1.1	1
	Reilly Tar & Chemical		2815	264,000	0	0	316	695	0	0	0	0
	Springville Hatchery		098	9,360,000	2.1	164	-	-	0.95	73	0.09	7
	Springville State Hatchery		098	6,790,000	3.0	167	640	35,665	2.04	114	0.19	11
	U.S. Steel-Geneva	001	331	25,000,000	6.9	1,439	514	107,169	26.6	5,546	1.2	250
		002	331	11,200	18	2	481	45	0.27	1	1.72	.2
	UP&L-Hale Plant	001	491	27,700,000	<5	-	0	0	0	0	0	0
		002	491	5,000	<5	-	5	0	.1	0	0	0
		003	491	17,500	<5	-	540	79	0	0	.37	0.05
Utah County Total				69,295,700		1,779		144,253		5,744		269
Wasatch	Clearview Trout Farm		098	2,837,000	4.2	99	185	4,360	4.6	109	.25	6
	Hecla Mining		1031	2,690,000	4	87	816	18,278	2	44	.75	46
	Midway Fish Hatchery		098	11,206,000	4.5	420	686	63,970	1.94	228	.225	21
Wasatch County Total				16,733,000		606		86,608		381		73
	BASIN TOTAL			163,928,410		7,706		1,317,309		8,942		7,076

of stream pollution more subtle than that attributable to point discharges of waste occurs as a result of man's use of the land.

For the purposes of this study it is necessary to identify the more serious diffuse sources of pollutants and to endeavor to quantify the waste loads that they impose on the surface waters. In general, runoff from agricultural lands, with the exception of irrigation return waters, has been assumed to be similar in quality to runoff from natural areas; thus it has not been regarded as a source of waste. This assumption does not hold during the spring, when animal manure is applied to cropland covered with melting snow.

The principal source of polluted runoff is the urban areas. Urban runoff is defined as the surface flow resulting from precipitation on natural and man-made surfaces in an urban environment. These flows may reach the receiving waters by overland flow, by collection and transport in a separate storm sewer or by collection and transport in a sanitary or combined sewer. To understand the nature of the urban runoff problem it is worthwhile to consider briefly the background to the problem.

In the late nineteenth and early twentieth centuries sanitary sewage collection systems were constructed in many cities to protect the public health. When storm water became a nuisance, it was a simple matter to discharge it to the same sewer system. Difficulties began to evolve when sewage treatment became a requirement. During storm periods the volume of combined sewage far exceeded the capacity of treatment facilities, generally designed with enough capacity to handle dry-weather flows, and the bulk of the flow was bypassed untreated to the receiving waters.

At essentially the same time as the recognition of the disadvantages of combined sewer systems, land development beyond the central core city began to accelerate. This posed two problems: the cost of conveying large volumes of storm runoff to the primary receiving waters and the inadequacy of the existing combined sewers to handle further flows. The solution adopted for the past 30 to 50 years has been to construct separate storm sewers designed to discharge overflows, with the least cost, into the nearest natural channel of sufficient capacity. Within the last decade, however, it has been realized that the urban runoff, even when not mixed with sanitary sewage, has a considerable, though generally unquantified, potential for degradation of receiving water quality (Reference 7-5 and 7-6).

A recent evaluation of storm water pollution in the Salt Lake City area (Reference 7-7) provided characterization of spatial and temporal variations of various pollutant waste loads during a given storm and over a season.

Within the Utah Lake and Jordan River basins urban runoff is conveyed to the natural drainage channels by means of both piped systems and open channels. No combined sewers exist within the basin although some storm water inevitably enters the sanitary system as a result of leakage around manhole covers and illicit connection of household roof drains, etc.

The pollutants contained in urban runoff are directly related to materials which accumulate in the urban environment as a result of man's activities. Examples are litter, animal feces, airborne particulate fallout, lawn fertilizers, pesticides and oil and grease from vehicles. The concentrations of these constituents in urban stormwater are related both to natural factors such as slope and intensity of rainfall and to management practices such as frequency of street sweeping. The multitude of locations at which urban runoff enters the surface waters within the basin makes it necessary to consider it as a non-point or diffuse source of pollutants.

Basis for Estimates

In common with most parts of the United States almost no information was available regarding quantity and quality of urban runoff. During the first year of the study many stormwater discharges were sampled to determine the quality of urban runoff. Measurement of flow quantities, however, was beyond the scope of the study.

Two approaches to estimating the total waste load imposed on the receiving waters by urban runoff were considered. One approach focuses on the development of an empirical relationship between pollutant mass emission rate and the characteristics of a particular city or urban area. Investigations conducted by Engineering-Science, Inc. (References

7-8, 7-9) in New York and in San Francisco led to development of the expression:

$$y = a/(b + i)$$

where: y is a pollutant mass emission rate per acre per inch of runoff;

i is inches of runoff; and

a and b are coefficients specific for each pollutant and drainage area.

Evaluation of a and b for different pollutants and different locations allows use of the expression for prediction.

The second approach is to compute mass emission rates on the basis of an average measured pollutant concentration in runoff samples. In view of the undeveloped nature of the predictive model it was decided that the latter approach should be adopted, although it is recognized that the concentration of pollutants will vary with conditions on the watershed, the nature of the sewer system and the frequency-intensity-duration characteristics of precipitation.

Urban runoff quantities were estimated for each planning area. The acreage within each of the planning areas devoted to urban uses was determined with reference to the master plans for Salt Lake, Utah and Davis counties and the Salt Lake Area Transportation Study (References 7-10, 7-11, 7-12, 7-13). Urban areas were further divided by land use into six categories: residential, commercial, industrial, institutional, utilities and transportation. Each category was assigned a runoff coefficient based on information used in the Salt Lake County Master Water and Sewer Plan (Reference 7-2). Runoff coefficients used are shown in Table 7-7. The same values for the coefficients were used throughout the basin since the many variables that determine runoff quantities (for example, ground slope, degree of paving and type of vegetative cover) were deemed to be reasonably similar in all urban areas within the Basin.

Total annual volume of urban runoff from each planning area was computed as the product of the area devoted to urban uses, average annual precipitation as determined from isohyetal maps and a weighted average runoff coefficient taking into account the relative proportions of land in different urban uses.

Table 7-7

RUNOFF COEFFICIENTS FOR URBAN AREAS

Land Use Type	Runoff Coefficient
Residential	0.35
Commercial	0.80
Industrial	0.60
Institutional	0.30
Utilities	0.50
Transportation	0.50

Average urban runoff quality in each planning area was estimated by sampling and analyzing the contents of storm drainage facilities throughout the Basin during rainfall. Urban runoff water quality data developed by the University of Utah for the Salt Lake City area (Reference 7-7) were taken into account in obtaining estimates for applicable areas. The somewhat higher values used herein reflect the conservative approach employed in evaluating sampling data for assessing the waste loads. Waste loads and the basic data used to develop them are shown in Table 7-8.

AGRICULTURAL WASTE LOADS

Agricultural activities result in the production of a number of significant categories of liquid wastes with relatively large total quantities. The most important of these wastes, from the point of view of environmental pollution, are irrigation return flows, animal wastes and food processing wastes. In this study, processing wastes (from the canning, freezing, meat packing and other agriculturally oriented industries) are treated as industrial waste loads.

Irrigation Return Flows

Irrigation wastewaters are by far the most significant sources of agricultural waste discharge into the natural drainage channels as well as the greatest non-point sources of wastewater contribution to the groundwater reservoir.

Table 7-8

UTAH LAKE-JORDAN RIVER HYDROLOGIC BASIN

URBAN RUNOFF WASTELOADS

Planning Area County		Total Area acres	Area in Urban Use acres	Water Quantity: Annual Precipitation inches	Water Quantity: Weighted Runoff Coefficient	Water Quantity: Runoff ACF/yr	Water Quantity: Quantity MGD	Waste Loads: BOD conc mg/1	Waste Loads: BOD load lb/day	Waste Loads: TDS conc mg/1	Waste Loads: TDS load lb/day	Waste Loads: Total Nitrogen conc mg/1	Waste Loads: Total Nitrogen load lb/day	Waste Loads: Total Phosphorus conc mg/1	Waste Loads: Total Phosphorus load lb/day
Davis	A	87,545	12,443	16	0.37	6,120	5.50	18.0	825	1,412	64,691	8.2	376	1.56	71
	B	40,466	2,633	16	0.44	1,541	1.47	18.0	220	454	5,560	15.0	193	0.75	9
	C	62,069	5,480	16	0.44	3,207	2.86	18.0	429	1,443	34,372	7.5	179	0.37	9
Salt Lake	D	73,701	12,245	16	0.57	9,283	8.34	18.1	1,257	1,065	73,986	5.8	403	3.6	250
	E	97,304	22,695	16	0.44	13,281	11.85	26.4	2,606	513	50,633	2.5	247	1.11	109
	F	128,323	18,878	16	0.465	11,945	10.57	17.3	1,506	949	71,344	3.8	365	1.095	111
	G	42,959	10,518	16	0.415	5,842	5.21	17.3	732	949	33,097	3.8	185	1.095	56
	H	147,313	9,886	16	0.425	5,614	5.18	17.3	737	949	34,797	3.8	180	1.095	51
Utah	I	135,806	12,022	14	0.45	6,312	5.63	8.8	413	375	17,584	7.0	328	2.25	106
Wasatch	J	329,426	906	16	0.305	276	0.25	21.5	44	248	517	1.7	4	9.1	19
Utah	K	89,835	0	-	-	0	0	0	0	0	0	0	0	0	0
	L	78,122	6,183	14	0.46	3,328	3.25	4.2	114	339	9,177	2.9	79	0.62	17
	M	99,900	4,400	14	0.40	2,059	1.84	2.5	38	395	6,051	5.4	83	0.56	9
	N	443,418	5,618	14	0.46	3,022	2.70	10.2	226	154	3,399	1.905	44	8.1	19
Utah/Juab	O	349,279	1,068	14	0.44	550	0.48	-	-	-	-	2.95	12	1.62	6

Basis for Estimates

The basic procedure for estimating the volume of irrigation return flows is summarized briefly prior to the discussion of those factors that affect the estimates. The area of irrigated lands and the volume of applied water were determined. The volume of water consumed by crops was estimated and the volume of return flow obtained by subtraction on consumption from application volume. This volume was then divided into two portions representing surface return flow to the stream channels and seepage into the groundwater reservoir.

In the Utah Lake-Jordan River Hydrologic Basins there are approximately 506,000 acres of arable land, of which about 50 percent is irrigated. A breakdown of agricultural land use, by county, is shown in Table 7-9. Approximately one-half of the irrigated acreage within the study area is located in Utah County. Water requirements for the irrigated lands were calculated on the basis of the "acre-foot-per-acre" allotments discussed previously and are summarized in Table 7-9.

Table 7-9
AGRICULTURAL LAND AND WATER USE

County	Arable Land (acres)	Irrigated Land (acres)	Water Use (acre-ft/yr)
Davis	55,400	36,500	127,800
Salt Lake	85,600	51,800	207,200
Utah	266,800	132,500	530,000
Juab	65,110	16,100	64,400
Wasatch	33,100	24,100	96,400

To determine the volume of excess irrigation water it is necessary to estimate the proportion of applied water that is consumptively used by crops in each area. Local average values of consumptive use by different crop types are presented in Table 7-10. Consumptive use is defined as the sum of transpiration use, that is, water passed through plants and either evaporated from the leaves or incorporated as plant tissue, and evaporation from adjacent soil and water surfaces. The acreage devoted to each crop type in each county is given in Table 7-11. Analysis of this information resulted in the development of the average values

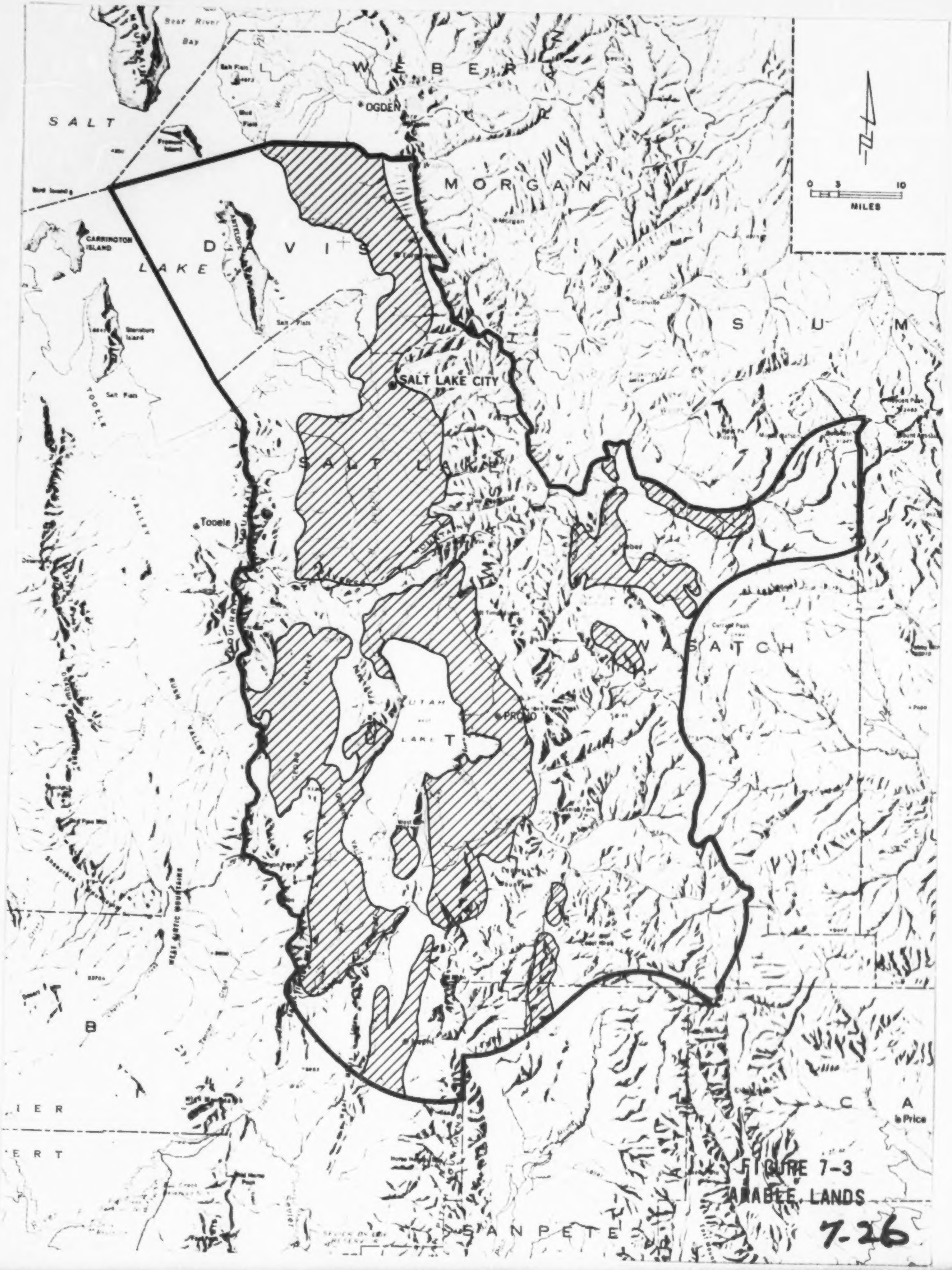
Bear River Bay
WEBER
OGDEN
SALT
LAKE
Fremont Island
CARRINGTON ISLAND
Stansbury Island
MORGAN
Morgan
DAVIS
Coalville
S U M
SALT LAKE CITY
Salt Flats
TOOELE
SALT LAKE
Tooele
VALLEY
RUSH VALLEY
WASATCH
Heber
UTAH LAKE
PROVO
U T
WEST TINTIC MOUNTAINS
B
IER
ERT
C A
Price
SANPETE
0 3 10
MILES

FIGURE 7-3
ARABLE LANDS

Table 7-10

AVERAGE CONSUMPTIVE USE FOR INDIVIDUAL CROPS

Crop	Water Requirement, acre-feet/acre
Alfalfa	3.0
Pasture	2.67
Hay	2.61
Corn	2.21
Sugar Beets	2.75
Grains	1.67
Orchards	2.38
Potatoes	2.10
Tomatoes	1.60
Peas	1.00

Source: U. S. Soil Conservation Service, 1973

Table 7-11

AREAS OF IRRIGATED CROPS BY COUNTY

(acres)

	County					
Crop Type	Davis(1)	Salt Lake(1)	Utah(2)	Juab(2)	Wasatch(2)	Total
Hay	11,708	13,864	41,893	4,896	13,003	85,364
Pasture	9,400	9,848	26,966	4,559	8,070	58,843
Grains	3,712	17,711	30,102	2,343	2,344	56,212
Corn	3,693	1,630	9,811	481	33	15,648
Sugar Beets	2,081	3,466	3,508	0	0	9,055
Potatoes	655	14	1,043	0	8	1,720
Orchards	714	307	8,382	158	0	9,561
Peas	ND	ND	93	0	0	93
Tomatoes	ND	ND	98	0	0	98
Beans	ND	ND	340	0	0	340
Small Truck	ND	ND	82	0	37	119
Idle Land	ND	ND	8,921	1,053	605	10,579
Other	4,537	4,960	1,261	2,610	ND	13,368
TOTAL	36,500	51,800	132,500	16,100	24,100	261,000

ND = No Data

Source: (1) Conservation Needs Inventory, 1970 (Reference 7-14).

(2) Water Related Land Use in the Utah Lake Drainage Basin, 1968 (Reference 7-15).

for consumptive use in each county which are displayed in Table 7-12.

A check on the accuracy of the estimates was obtained by calculating the irrigation efficiency in each county and comparing the values obtained by calculation with those obtained from other sources. Irrigation efficiency is defined as the ratio of consumptive use less precipitation during the growing season to diverted water, expressed as a percentage. Calculated values for each county are shown in Table 7-12. The staff of the Soil Conservation Service estimate irrigation efficiencies in the study area to be within the range of 30 to 45 percent.

Based on the estimated irrigation efficiencies, the volumes of irrigation return flows were calculated and are displayed in Table 7-13. These volumes represent the excess water diverted over and above that required to grow crops. These excess flows percolate into the groundwater or return to the surface streams. The proportion of return flow following either route depends on many factors, including soil characteristics over the irrigated area, irrigation method used and the presence or absence of tile or other drainage systems.

In order to estimate the proportions of excess irrigation water flowing to the groundwater and surface streams, return flow rating factors were developed for each county taking account of the three most important factors: soil characteristics, type of drainage and irrigation method. Little basic data were available with respect to the latter factors. Information was obtained from the Soil Conservation Service and from agricultural experts familiar with each area; however, the degree of precision of the estimates is probably low.

Soil maps were examined and the irrigated acreages divided into three generalized soil categories: sandy loams, medium loams and heavy clays. The proportion of excess applied water that runs off from each soil type is shown in Table 7-14, assuming no under drainage and irrigation by the furrow method.

For land that is artificially drained by tile or other systems, it was assumed that 90 percent of the excess applied water is collected by the drainage system and is discharged to the surface streams. It was also assumed that sprinkler irrigation results in no runoff to the surface streams. The estimated extent of sprinkler irrigated and artificially drained loads in each county is shown in Table 7-15.

Table 7-12

CONSUMPTIVE USE AND IRRIGATION EFFICIENCY

County	Average Consumptive Use, acre-ft/acre	Average Growing-Season Precipitation, acre-ft/acre	Irrigation Efficiency, percent
Davis	2.46	0.70	50.3
Salt Lake	2.46	0.60	41.5
Utah	2.24	0.60	41.0
Juab	2.33	0.58	43.8
Wasatch	2.54	0.62	48.0

Table 7-13

TOTAL IRRIGATION RETURN FLOWS

County	Water Diverted	Crop Water Requirements	Total Irrigation Return Flow
		acre-ft/yr	
Davis	127,800	64,280	63,520
Salt Lake	207,200	85,990	121,210
Utah	530,000	217,300	312,700
Juab	64,400	28,210	36,190
Wasatch	96,400	46,270	51,130

Table 7-14

RUNOFF FROM VARIOUS SOIL CATEGORIES

Soil Category	Percentage of Excess Applied Water	
	to Groundwater	to Surface Streams
Sandy loams	91	9
Medium loams	71	29
Heavy clays	37	63

Table 7-15

ESTIMATED ARTIFICIALLY DRAINED AND/OR SPRINKLER-IRRIGATED AGRICULTURAL LANDS IN EACH COUNTY

(percent of total irrigated land)

County	Artificially Drained	Sprinkler-Irrigated
Davis	28	5
Salt Lake	14	11
Utah	14	20
Juab	0	<1
Wasatch	3	9

Irrigation return flow routing factors are shown in Table 7-16 and the estimated annual volumes of return flow discharged to the groundwater and the surface streams are shown in Table 7-17.

Table 7-16

IRRIGATION RETURN FLOW ROUTING FACTORS

County	Percentage of Total Irrigation Return Flow	
	to Groundwater	to Surface Waters
Davis	54	46
Salt Lake	62	38
Utah	67	33
Juab	71	29
Wasatch	79	21

Total waste load applied to the surface waters of the Basin, as a result of agricultural irrigation, depends on both quantity and quality of the return flows. Information on the quality of irrigation return flow, as reported in the technical literature, is both meager and highly variable. Generalized values of the irrigation use increment for several parameters were developed on the basis of the results of studies at other locations (References 7-16, 7-17, 7-18) and verified by limited local sampling and analysis. The incremental values are displayed in Table 7-18 and represent the increase in pollutant concentrations resulting from agricultural use.

Table 7-17

IRRIGATION RETURN FLOW TO GROUNDWATER AND SURFACE STREAMS

County	Irrigation Return Flow to Groundwater (acre-ft/yr)	Irrigation Return Flow to Surface Waters (acre-ft/yr)
Davis	34,480	29,040
Salt Lake	75,310	45,890
Utah	210,910	101,790
Juab	25,695	10,495
Wasatch	39,480	10,645

Table 7-18

INCREMENTS OF POLLUTANT PARAMETERS CONTRIBUTED BY IRRIGATION RETURN FLOW TO SURFACE WATERS

Parameter	Concentration Increment in Surface Runoff Flows (mg/l)	Concentration Increment in Tile Drains (mg/l)
BOD	2.25	1.5
TDS	250	850
Total N	3.2	8.0
Total PO_4	0.5	0.5

It can be observed that return flow collected in tile drains is more polluted with inorganic constituents than is surface runoff because of the longer period of contact with the soil. On the other hand, organic materials, and phosphorus, are reduced as a result of infiltration through the soil.

Mass Emission Rates

Mass emission rates of biochemical oxygen demand, total dissolved solids, total nitrogen and total phosphorus imposed on the surface streams from agricultural irrigation were calculated for each county on the basis of the foregoing quantitative and qualitative estimates. The results are shown in Table 7-19.

Table 7-19

IRRIGATION WASTE LOADS IMPOSED ON THE SURFACE WATERS

County	Flow (acre-ft/yr)	Flow (MGD)	Waste Load, lb/day BOD	TDS	Total Nitrogen	Total Phosphate
Davis	29,040	25.9	397	125,571	1,264	108
Salt Lake	45,890	41.0	684	153,697	1,640	171
Utah	101,790	90.9	1,485	365,546	3,856	379
Juab	10,495	9.4	176	19,537	250	39
Wasatch	10,645	9.5	171	25,883	302	40

Pesticides and Herbicides in Agricultural Drainage

Pesticides and herbicides from agricultural applications are a potential source of toxicity. Areas of usage within the Utah Lake-Jordan River study area are shown in Figures 7-4 and 7-5 (Reference 7-19). Chlorinated hydrocarbon pesticides of greatest concern are DDT, DDE, dieldrin, aldrin, BHC (Lindane) and heptachlor. Pesticides and their break down products, if present, are generally in very low levels such as parts per billion or parts per trillion. Absorption and assimilation by aquatic organisms in higher trophic levels may concentrate the pesticide several hundredfold. Extreme pesticide concentrations may interfere with metabolism and reproduction and lead to ultimate death. The Federal government sets a maximum pesticide level of seven parts per million in fish to be consumed by the population.

No attempt was made to quantify herbicide or pesticide waste loads, although they do remain a potentially serious pollutant.

Waste Loads from Animal Husbandry

Animal wastes can pose a serious threat to water quality, especially when the animals are concentrated within dairies or feedlots. In the

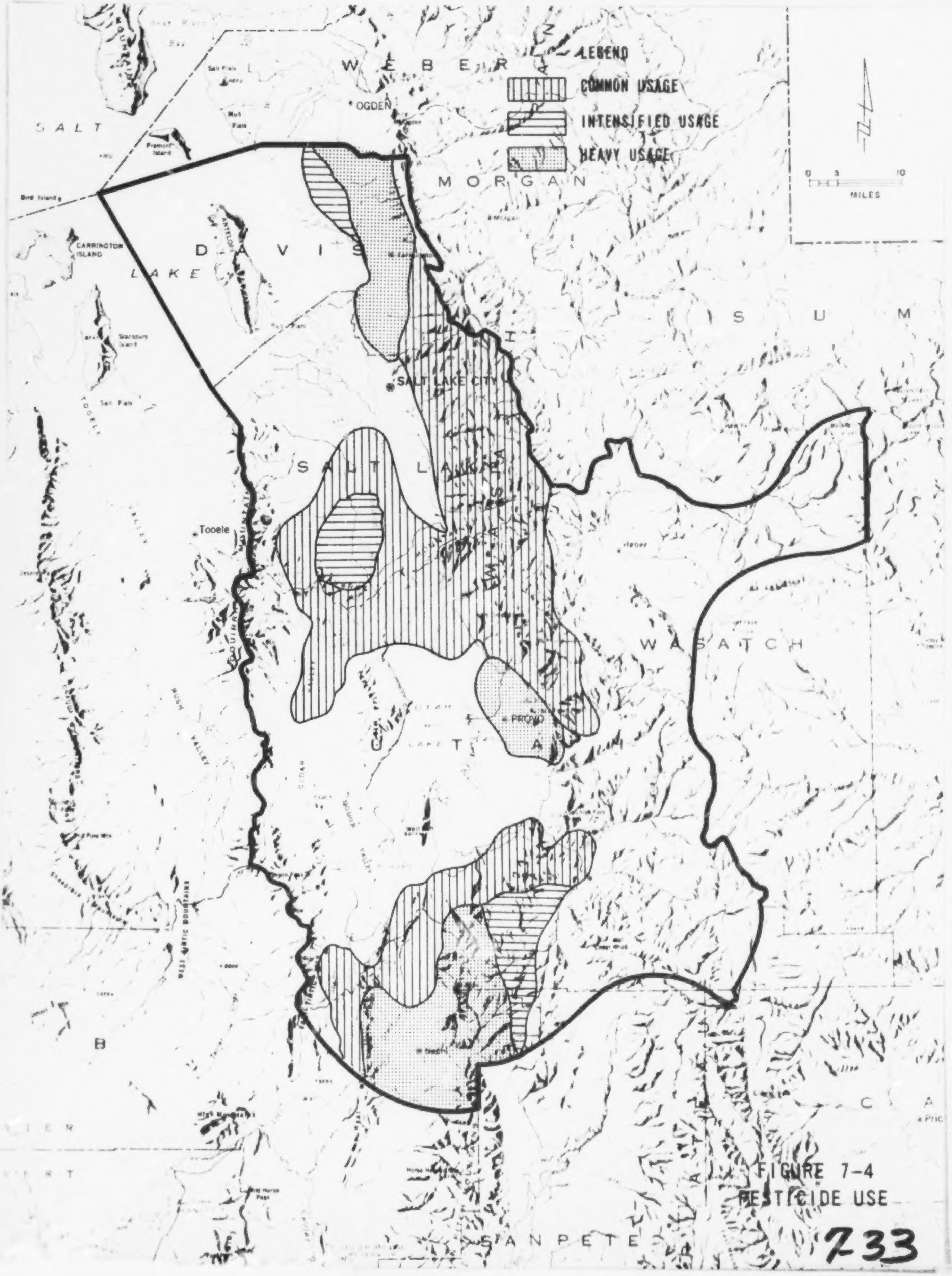
LEGEND
COMMON USAGE
INTENSIFIED USAGE
HEAVY USAGE
0 3 10
MILES
WEBER
OGDEN
MORGAN
SALT
Promontory Island
Bird Island
CARRINGTON ISLAND
DAVIS
LAKE
ANTELOPE
Stansbury Island
Salt Flats
TOOELE
SALT LAKE CITY
SALT LAKE
Tooele
Heber
SUMMIT
WASATCH
UTAH
LAKE
PROVO
WEST TINTIC MOUNTAINS
RUSH VALLEY
CEDAR VALLEY
GOSHEN VALLEY
B
SANPETE
C A
Price

FIGURE 7-4
PESTICIDE USE

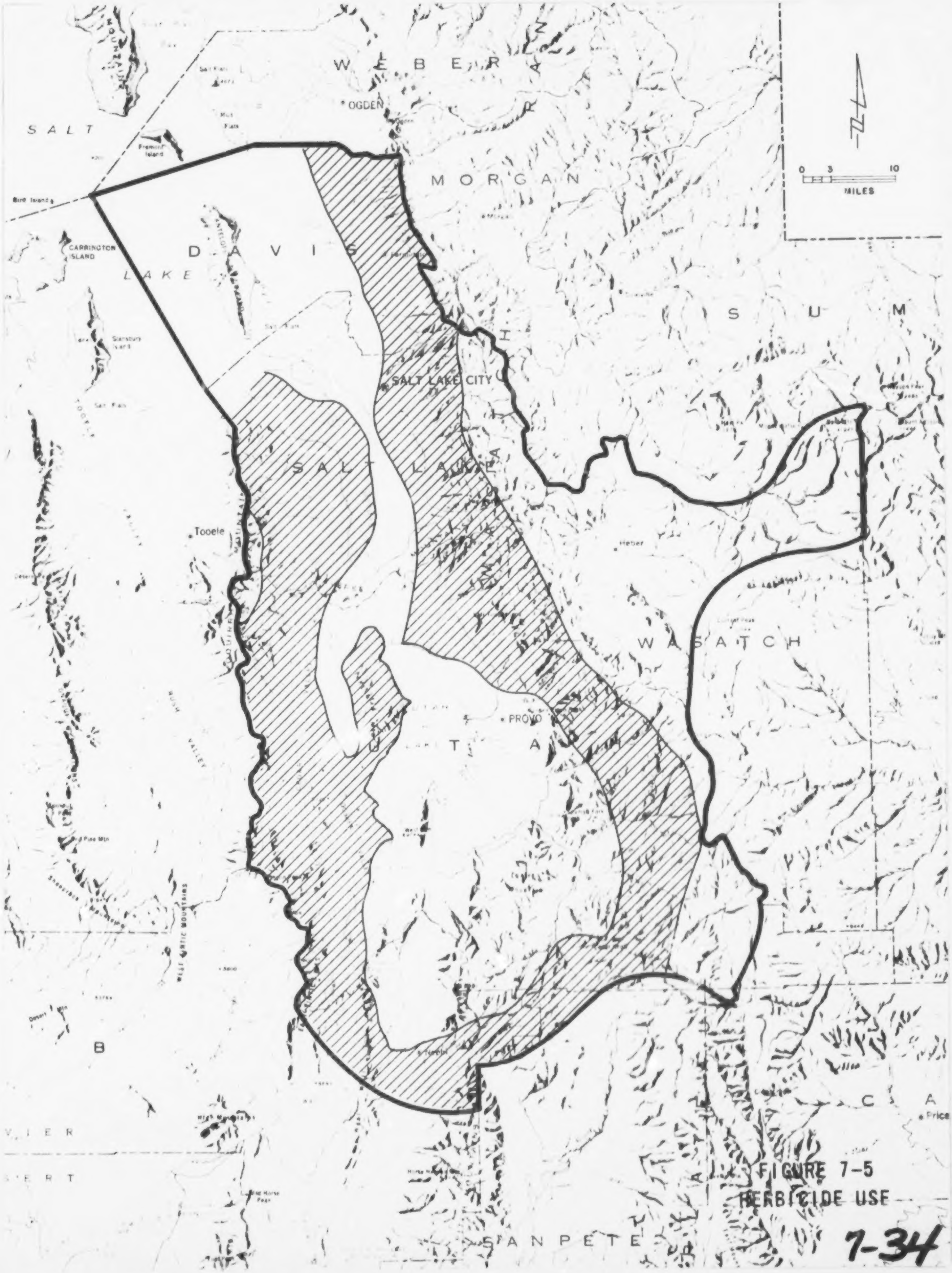
WEBER
OGDEN
SALT
Fremont Island
Bird Island
MORGAN
0 3 10
MILES
CARRINGTON ISLAND
DAVIS
LAKE
Stansbury Island
SALT LAKE CITY
SUM
SALT LAKE
Tooele
Heber
WASATCH
PROVO
UTAH
B
VIER
SERT
SANPETE
CA
Price

FIGURE 7-5
HERBICIDE USE

study area, animal populations and their resultant wastes are, with a few exceptions, dispersed throughout the entire farmed area. Farms are small and support a variety of domestic animals in relatively small numbers.

The type and number of animals raised in the study area are shown in Table 7-20. Approximately two-thirds of the cattle are dairy cattle, the remainder being raised for beef. During the spring and summer, the dairy cattle are pastured. Beef cattle are grazed on mountain ranges. In the winter, cattle are concentrated in small corrals and the manure is stockpiled for spreading on the fields in early spring.

Table 7-20

AGRICULTURAL ANIMAL POPULATION

Type of Animal	Population
Cattle	125,000
Sheep	160,000
Hogs	11,000
Poultry	1,200,000
Horses	6,000

Sheep raising is practiced in Southern Utah and Juab counties. Sheep are grazed on the high ranges in the mountains during summer and moved to the western desert for the winter. A few small sheep feedlots (500-1,000 head) are operated in the Mapleton and Spanish Fork areas.

Most of the poultry raised in the study area are kept in the western portion of the Salt Lake Valley. Wastes are handled in total containment lagoons or by land disposal.

Water pollution can be caused by animals in a number of ways. The volume of excreta concentrated in a small area at a feedlot can be a year-round source of polluted runoff unless containment facilities are provided. Excreta from grazing animals, or manure spread on fields, may degrade the quality of storm runoff as it flows to the streams or groundwater. Animals watering at unfenced natural streams introduce waste directly into the surface waters. The pollution potential of animal wastes is shown in Table 7-21 (References 7-20, 7-21). Table 7-22 shows the human population equivalent of animal wastes in the study area with respect to several parameters.

TABLE 7-21

CHARACTERISTICS OF ANIMAL WASTES

Animal	Body Weight, lbs	TDS	BOD	Total Nitrogen	Total Phosphate
		lbs/day			
Chicken	4.5	-	0.015	0.0033	0.0026
Hog	100	-	0.33	0.055	0.025
Dairy Cattle	1,000	3.62	1.20	0.41	0.12
Beef Cattle	1,000	1.70	1.02	0.26	-
Homo Sapiens	150	-	0.17	0.018	0.007

TABLE 7-22

POPULATION EQUIVALENTS OF ANIMAL WASTES IN STUDY AREA

Parameter	Population Equivalent
BOD	1,200,000
Total Nitrogen	3,100,000
Total Phosphate	2,700,000

It is almost impossible to estimate the quantities of pollutants from animal waste that find their way into the surface or groundwaters. Factors that affect these quantities include density of animal population, animal husbandry management methods, ground slope, soil permeability, soil type, precipitation type, type of vegetative cover and many others. No attempt was made to integrate animal waste loads into the overall basinwide waste load estimates.

TOTAL WASTE LOADS APPLIED TO THE SURFACE STREAMS

If management of water quality is to be accomplished effectively and efficiently, the magnitude and mode of application of wastes from different sources must be clearly understood. In the preceding sections of this chapter, waste loads from various sources have been described and quantified. The purpose of this section is to synthesize an integrated picture of basinwide loads.

Table 7-23 shows the present waste loads imposed on the surface waters by county and waste source.

In the context of the entire study area, municipal wastewaters represent 22 percent of the 522 million gallons of waste flow produced daily and 56 percent of the biochemical oxygen demand. Discrete industrial waste discharges account for 31 percent of the daily flow, 17 percent of the biochemical oxygen demand and 43 percent of the total dissolved solids. Irrigation return flow represents 34 percent of the daily flow and 22 percent of the total dissolved solids. The remaining 13 percent of the daily waste flow is urban runoff. Most of the nitrogen and phosphorus is contained in municipal wastewaters, although a substantial nitrogen load is applied to Utah Lake by the U.S. Steel Geneva works.

The greater part of the municipal waste load is applied to streams in Salt Lake County. Industrial waste loads are most significant in Salt Lake and Utah counties, although the high-salt load contributed by industry in Salt Lake County is discharged close to the Great Salt Lake and consequently has less of a negative impact on water quality than might otherwise be expected. Irrigation return flows are of significantly high volume throughout the study area.

WASTE LOAD PROJECTIONS

In any planning study, decisions and recommendations for action must be based not only on current conditions but also on conditions which are expected to exist in the future. Waste load projections are inherently difficult to make because they are influenced by many complicated and interrelated factors, including the rates of economic and population growth and the levels of waste treatment technology available and adopted.

Table 7-23

WASTE LOADS IMPOSED ON THE SURFACE WATERS

County	Flow, MGD	BOD	TDS	Total N	Total PO_4
		lbs/day			
Davis County					
Municipal	17.8	2,783	97,275	6,450	4,294
Industrial	3.5	845	34,010	1,773	346
Irrigation Return Flow	25.9	397	125,571	1,264	108
Urban Runoff	9.8	1,474	104,623	738	89
County Total	57.0	5,499	361,479	10,225	4,837
Salt Lake County					
Municipal	69.9	17,034	473,988	16,113	14,775
Industrial	74.4	4,476	1,052,438	1,044	6,388
Irrigation Return Flow	41.0	684	153,697	1,640	171
Urban Runoff	41.1	6,838	263,857	1,380	577
County Total	226.4	29,032	1,943,980	20,187	21,911
Utah County					
Municipal	25.0	5,020	84,562	5,355	4,287
Industrial	69.3	1,779	144,253	5,744	269
Irrigation Return Flow	90.9	1,455	365,546	3,856	379
Urban Runoff	13.9	791	36,211	546	157
County Total	199.1	9,075	630,572	15,501	5,092
Wasatch County					
Municipal	2.8	468	8,511	1,351	429
Industrial	16.7	606	86,608	381	73
Irrigation Return Flow	9.5	171	25,883	302	39
Urban Runoff	0.3	44	517	4	19
County Total	29.3	1,289	121,519	2,038	560
Juab County					
Municipal	0.3	70	1,616	37	23
Irrigation Return Flow	9.4	176	19,537	250	39
County Total	9.7	246	21,153	287	62
BASIN TOTAL	521.8	45,141	3,078,703	48,238	32,462

Basis for Estimates

Flow projections were made for each separate waste-producing category: municipal wastes, industrial wastes, irrigation return flow and urban runoff. No attempt was made to project pollutant loads due to the high degree of uncertainty involved.

Future municipal waste flows were estimated on the basis of the population projections described in Chapter 4. Projection of industrial waste flows probably involves the greatest degree of uncertainty. For the purpose of the study, it was assumed that the increase in wastewater flows resulting from a higher level of industrial activity would be balanced by the introduction of water-conserving practices. Both future irrigation return flows and future urban runoff quantities were estimated on the basis of projected agricultural and urban land use.

Future Wastewater Flows

Future wastewater flows are shown in Table 7-24. The most significant conclusion to be drawn from these projections is that the importance of municipal wastewaters in terms of basin-wide waste flows increases with time. With the application of advanced treatment technology, however, pollutant loads from municipal sources should decrease.

TABLE 7-24

FUTURE WASTEWATER FLOWS

Source	1972	1978	1985	1995
	MGD			
Municipal	116	141	162	196
Industrial	164	165	165	165
Irrigation Return Flow	177	173	167	163
Urban Runoff	65	73	80	92
Total	522	522	574	616

REFERENCES

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7-21. "Role of Animal Wastes in Agricultural Land Runoff," EPA, 1971.

CHAPTER 8

WATER RESOURCES DEVELOPMENT

This chapter includes an inventory of the existing and proposed water supply facilities in the study area and a discussion of the impact of the proposed developments on water quality management programs.

The major suppliers of potable water in the basins include the Weber Basin Water Conservancy District, Salt Lake County Water Conservancy District, Metropolitan Water District, Salt Lake City Water Department, Provo City Water Department, Orem City Water Department, and the Central Utah Water Conservancy District. Many smaller municipal, district, and private supplies exist. In addition, 192 irrigation companies supply water for agricultural use. The Weber Basin Water Conservancy District obtains water from the Weber and Ogden Rivers and provides water supplies to Weber and Davis Counties. The Salt Lake County Water Conservancy District and Metropolitan Water District of Salt Lake City obtain their supplies from the Provo River Project, which diverts a portion of the Weber River headwaters via the Weber-Provo Diversion Canal and Duchesne River via the Duchesne Tunnel. The Metropolitan Water District provides water primarily to Salt Lake City but can deliver water to Utah and Salt Lake Counties for irrigation and municipal purposes.

The high level of water resource management in the study area is due principally to an arid climate and local demands which exceed locally available sources of supply. Extensive reservoir and canal systems divert water from one location in the study area to meet demands at other locations. These projects reduce the amount of water available downstream of the diversions for other beneficial uses. In certain areas, such as on the Jordan, Provo, Spanish Fork, and American Fork Rivers, the magnitude of the diversions affects the quality of water by controlling the quantity of water available to dilute lesser quality inflows such as irrigation return flows and wastewater treatment plant effluents.

Total water use for municipal, industrial, agricultural and recreational purposes in the Utah Lake-Jordan River Hydrologic Basins is estimated to be 1,490,823 acre-feet/year (1,330 mgd) at present. This demand is projected to increase 30 percent by the year 2020, as discussed in a previous chapter. Most of the increase will occur in Davis and Salt Lake Counties. Water use in Wasatch County is projected to decline slightly over the next 50 years.

It is clear that new sources of water must be developed in the future to sustain growth in the study area. The water resources of the study area itself are fully developed and the water needs of the area are already met to a large extent by inter-basin transfers. At the present time, approximately one-fifth of the water supply to Utah Lake is diverted from other basins. It is clear that much of the area's future water supply must also be imported from outside the study area unless major reallocation and reuse of existing supplies occurs.

A major conveyance route for water supply in the study area is through Utah Lake and the Jordan River. Many diversions are made for industrial and agricultural purposes as water flows toward the Great Salt Lake. Listed in Table 8-1 are the major diversions from the Jordan River. Diversions for irrigation purposes occur during the growing season from May to September.

MAJOR INTER-BASIN WATER RESOURCE DEVELOPMENT PROJECTS

Central Utah Project (CUP)

Utah's share of the Colorado River water is approximately 1.5 million acre-feet per year. Sixty percent of Utah's allotment is produced in the Uinta Mountains and only half of this is utilized by Utah. The remainder flows out of the state for use by lower Colorado River states. The Central Utah Project is a major statewide effort designed to make a portion of this water available to the urban areas near Salt Lake City and Provo through a series of dams, reservoirs, and aqueducts (Figure 8-1).

The largest unit of the Central Utah Project which will affect the Utah Lake-Jordan River Hydrologic Basins study area is the Bonneville Unit. The Bonneville Unit of the Central Utah Project will cost over $450 million and will take 25 years to complete. Water from the Uinta Mountains will be diverted through the Strawberry Aqueduct to the enlarged Strawberry Reservoir, then to Utah Valley for further distribution to points both north and south. The first step toward supplying additional water for the Bonneville Basin was taken with the construction of Water Hollow Tunnel, part of the Strawberry enlargement complex. Water Hollow Tunnel is the first section to be completed of 38 miles of tunnels and aqueducts which will deliver surplus Uinta Mountain water into the enlarged Strawberry Reservoir. The

Table 8-1

MAJOR WATER DIVERSIONS FROM THE JORDAN RIVER[1]

Withdrawal	User	1971, 1972 Average Diversion (acre-feet/year)
Jordan and Salt Lake Canal	Salt Lake City Corp.	12,378
East Jordan Canal	Salt Lake City Corp.	15,505
East Jordan Canal	E. Jordan Irrigation Co.	42,699
Draper Irrigation Canal	Draper Irrigation Co.	13,921
Galena Canal	Irrigators	1,380
	U.S. Smelter	5,800
Utah and Salt Lake Canal	Kennecott Copper Co.	53,105
	Others	1,616
South Jordan Canal	S. Jordan Canal Co.	35,827
Beckstead Farm Diversion	Beckstead Farm	1,088
North Jordan Canal	Kennecott Copper Co.	29,573
	N. Jordan Canal Co.	13,708
Gardner Mill Race	Irrigators	788
Surplus Canal	Flood Control/Irrigation	273,450
	Total	500,838

[1] Data Source: Engineering Experiment Station, University of Utah, Salt Lake City, Utah

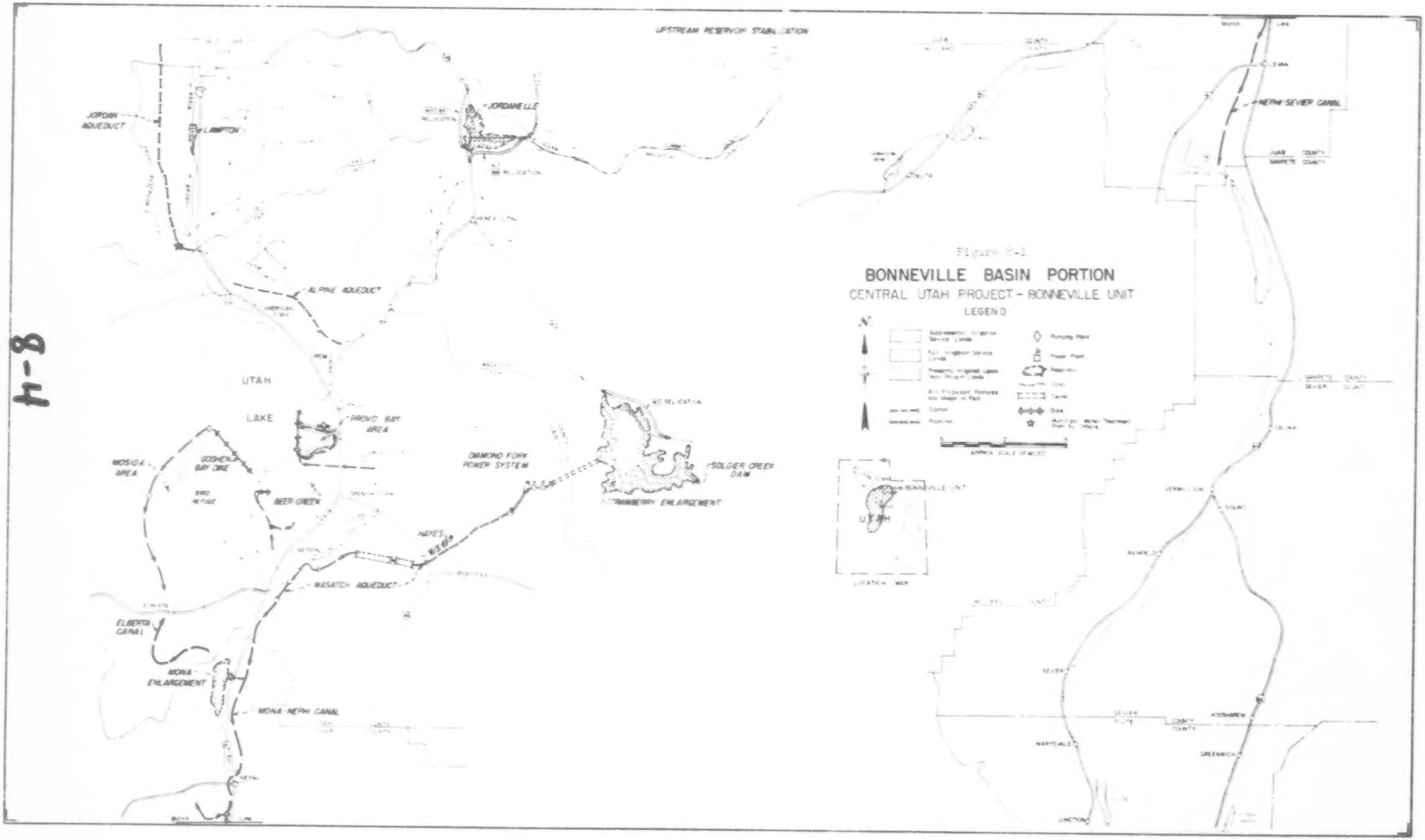


Figure 8-1

BONNEVILLE BASIN PORTION

CENTRAL UTAH PROJECT - BONNEVILLE UNIT

LEGEND
N
LOCATION MAP
UTAH
BONNEVILLE UNIT
UPSTREAM RESERVOIR STABILIZATION
JORDAN AQUEDUCT
LAMPTON
JORDANELLE
ALPINE AQUEDUCT
UTAH
LAKE
PROVO BAY AREA
MOSIDA AREA
GOSHEN BAY DIKE
BEER CREEK
DIAMOND FORK POWER SYSTEM
SOLDIER CREEK DAM
STRAWBERRY ENLARGEMENT
HAYES
WASATCH AQUEDUCT
ELBERTA CANAL
MONA ENLARGEMENT
MONA-NEPHI CANAL
NEPHI-SEVIER CANAL
JUAB COUNTY
SANPETE COUNTY
SEVIER COUNTY
VERMILLION
RICHFIELD
SEVIER
KOOSHAREM
MARYSVALE
GREENWICH
JUNCTION

Strawberry Reservoir has been increased in capacity from 270,000 to 1,106,500 acre-feet. In high runoff-water years, more storage will be available, thus lessening flood threat. There will be two additional reservoirs along the Strawberry Aqueduct, which will serve as regulating reservoirs and will also be developed into recreational areas. Water will be released from Strawberry Reservoir through the pressurized Syar Tunnel traversing the Great Basin divide. It will then pass into the Syar, Sixth Water and Dyne power plants, respectively. As the water comes down Diamond Fork Canyon, it will either be stored in the new Hayes Reservoir or be diverted into the Wasatch Aqueduct. Hayes Reservoir will release water into Utah Lake and to the southern part of Utah County for municipal and agricultural purposes. Another feature of the Bonneville unit is improved utilization of Utah Lake. The lake has a capacity of more than 850,000 acre-feet but loses an estimated 300,000 acre-feet annually to evaporation. The lake area, under current planning, will be reduced by diking, thus reducing evaporation. Provo Bay and Goshen Bay are proposed to be diked off from the rest of the lake, reducing the surface area by approximately one-third. The water now being lost through evaporation will then be stored in the proposed Jordanelle Reservoir in Wasatch County where the evaporation losses will be greatly reduced as a result of the cooler temperature and reduced surface area. The reclaimed Provo Bay area would be developed into a new agricultural area. It is proposed to develop Goshen Bay as a game preserve. Water from the Jordanelle Reservoir will be released into the Provo River through Deer Creek Reservoir and then to the Jordan Aqueduct. The Jordan Aqueduct will supply water to Salt Lake County. A new water treatment plant has been completed by the Central Utah Water Conservancy District in southwestern Salt Lake County to provide culinary water service to the western portion of the county. Waters will also be released from Jordanelle Reservoir to meet Northern Utah County municipal requirements.

Following completion of Starvation Reservoir in 1959 and the topping out of the Strawberry Reservoir enlargement in 1972, the CUP has slowed down measurably. All projects have been curtailed pending approval of the program, Currant Creek Reservoir will be the next project completed (1976), followed by Lampton Dam.

When completed, the CUP will deliver approximately 136,000 acre-feet of water per year from the Uinta Basin to Strawberry Reservoir.

Water Resources Development--Davis County

There are 76 miles of streams which flow through Davis County and discharge to the Great Salt Lake. The mean annual discharge is 23,500 acre-feet. Davis County has no major fresh water lakes or reservoirs and only a few small private reservoirs.

Weber Basin Project--

The Weber Basin project was planned and constructed by the U.S. Bureau of Reclamation and is maintained and operated by the Weber Basin Water Conservancy District and serves Weber, Morgan, Summit, Davis, and a portion of Box Elder County.

Approximately 13,000 acre-feet are diverted annually from the Weber River near Morgan and transported via the Davis Aqueduct for municipal and industrial use in Davis County. The aqueduct transports raw water to two Weber Basin Water Conservancy District water treatment plants.

The Weber Basin project also supplies considerable irrigation water to Davis County. The irrigation water is supplied via a pressure pipeline. Approximately 42,000 acre-feet of water for agriculture is supplied annually to Davis County from the Weber River diversion.

Water Resources Development--Salt Lake County

Salt Lake County contains 262 miles of streams with a total drainage area of 192 square miles. The Jordan River contributes 234,700 acre-feet of the total runoff of 380,812 acre-feet for Salt Lake County. Water storage consists mainly of small high-mountain lakes and several reservoirs. A total storage of 8,358 acre-feet is impounded, covering 107 acres.

Water Suppliers--

The Salt Lake County Water Conservancy District serves part of the area within Salt Lake County. Sources of water originate in streams flowing out of mountains along the Wasatch Front, from wells and from Deer Creek Reservoir via the Salt Lake Aqueduct. The streams supplying water include Little Cottonwood, Big Cottonwood, Mill Creek, Parleys Creek, Emigration, City Creek and Little Dell. The streams supply an estimated 85,080 acre-feet per year for municipal, industrial and agricultural use.

The Metropolitan Water District was organized to provide water for domestic, industrial and agricultural uses in Salt Lake City with surplus' being purchased by other entities of the county. The district owns the water purification plant at the mouth of Little Cottonwood Canyon and supplies water to water users and irrigation companies throughout Salt Lake County. Water for potable use is supplied to the west side of both Salt Lake and Utah Counties via the Provo Reservoir Canal and Jordan Narrows Pumping Station.

The Central Utah Water Conservancy District was organized to supply municipal, industrial and agricultural water to Salt Lake, Utah, Sanpete and Juab Counties. The district evolved as a result of the Central Utah Project which is discussed at the beginning of this chapter. The main facility for potable water supply owned by the district is the Jordan Water Purification Plant located near Bluffdale at the south end of Salt Lake County. The Jordan plant is now operational and provides treated water to relieve the growing water demands in Salt Lake County. Water sources to the plant are made available by the Bonneville Unit of the Central Utah Project. Water from the south slopes of the Uinta Mountains is diverted and stored in Deer Creek Reservoir and eventually in the proposed Jordanelle Reservoir; then through controlled releases and exchanges, water will be made available to Salt Lake County for municipal uses.

Table 8-2 summarizes Salt Lake County's 1971 water sources and its projected 1985 sources.

Central Utah Project--

Key elements of the Central Utah Project which will be constructed in Salt Lake County include the Jordan Aqueduct and Lampton Dam as shown in Figure 8-2. During summer months, water stored at Jordanelle Reservoir near Heber will be released to the Provo River. The Provo Reservoir Canal will intercept it at the Murdock Diversion Dam and convey it to the Point-of-the-Mountain, where it will be transferred to the Jordan Aqueduct and delivered to the new Central Utah Water Conservancy District treatment plant near Bluffdale. The treated water will enter a distribution system for west Salt Lake Valley. The new water treatment plant will serve

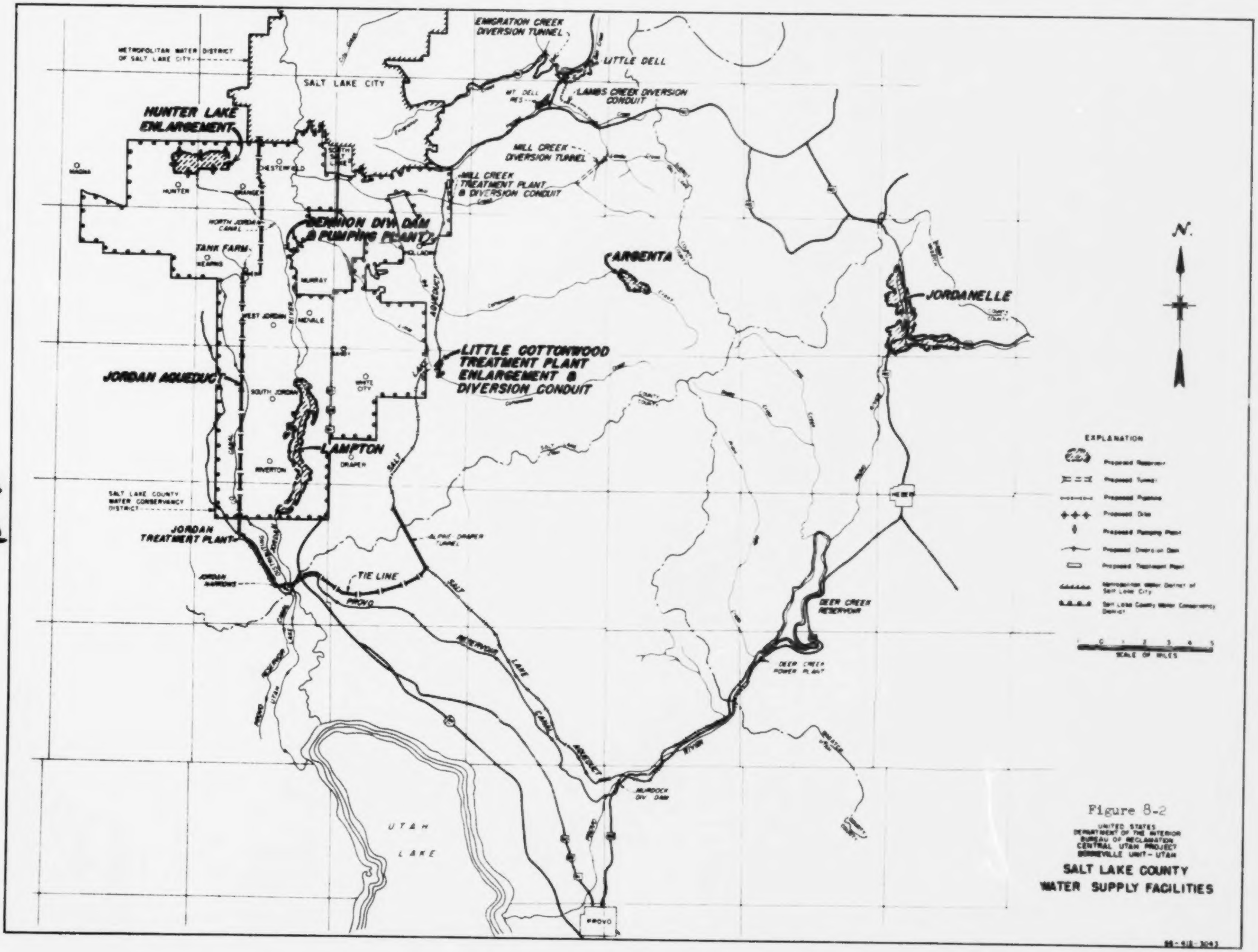

EMIGRATION CREEK DIVERSION TUNNEL
LITTLE DELL
METROPOLITAN WATER DISTRICT OF SALT LAKE CITY
SALT LAKE CITY
MT. DELL RES.
LAMBS CREEK DIVERSION CONDUIT
HUNTER LAKE ENLARGEMENT
MILL CREEK DIVERSION TUNNEL
MILL CREEK TREATMENT PLANT & DIVERSION CONDUIT
MAGNA
HUNTER
GRANGER
CHESTERFIELD
NORTH JORDAN CANAL
JORDAN DIV. DAM & PUMPING PLANT
TANK FARM
KEARNS
ARGENTA
MURRAY
WEST JORDAN
MIDVALE
JORDANELLE
LITTLE COTTONWOOD TREATMENT PLANT ENLARGEMENT & DIVERSION CONDUIT
AQUEDUCT
JORDAN AQUEDUCT
SOUTH JORDAN
WHITE CITY
LAMPTON
RIVERTON
DRAPER
SALT LAKE COUNTY WATER CONSERVANCY DISTRICT
JORDAN TREATMENT PLANT
ALPINE DRAPER TUNNEL
TIE LINE
JORDAN NARROWS
PROVO
SALT
RESERVOIR
LAKE
CANAL
AQUEDUCT
HEBER
DEER CREEK RESERVOIR
DEER CREEK POWER PLANT
MURDOCK DIV DAM
UTAH LAKE
PROVO
N.
EXPLANATION
Proposed Reservoir
Proposed Tunnel
Proposed Pipeline
Proposed Dike
Proposed Pumping Plant
Proposed Diversion Dam
Proposed Treatment Plant
Metropolitan Water District of Salt Lake City
Salt Lake County Water Conservancy District
1 0 1 2 3 4 5
SCALE OF MILES

Figure 8-2

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL UTAH PROJECT
BONNEVILLE UNIT - UTAH

SALT LAKE COUNTY
WATER SUPPLY FACILITIES

Table 8-2

SALT LAKE COUNTY - WATER SOURCES

Source	1971 (acre-feet)	1985 (acre-feet)
Stream Flow	48,000	39,800
Ground water	36,000	48,000
Mountain Dell Storage	700	700
Peaking Wells	11,000	13,000
Provo River Project	33,500	45,500
Central Utah Project	--	94,000
Total Acre-Feet	130,000	251,000

as a peaking plant, then as potable water demands increase, the plant will be operated on a full time basis. In winter months during low potable water demand, when canal transport is not feasible, the Bonneville Unit water will be carried through the Salt Lake Aqueduct to the Little Cottonwood plant for treatment and then delivered to the Jordan Aqueduct via cross-valley ties lines distribution. The aqueduct will provide an additional water source of 94,000 acre-feet annually to Salt Lake County.

Lampton Dam and Reservoir--Lampton Dam is planned for the Jordan River near 9800 South. It would impound water for a distance of approximately six miles to Bluffdale and create a reservoir holding 48,000 acre-feet. The reservoir and surrounding area is planned as a multipurpose facility and is part of the Salt Lake County Master Plan, under the name of Jordan Lake.

Recently there has been a proposal to divide the Lampton Reservoir into two smaller impoundments. The first dam at 9800 South would create a reservoir extending to 12600 South. A smaller dam would then be constructed at about 13000 South which would create a reservoir extending to Bluffdale. The smaller, southernmost reservoir would act as a desiltation and stabilization basin which would increase the quality of water in the main Lampton Reservoir. Major recreational facilities would be limited to the improved waters of Lampton Reservoir, with only a limited usage of the upper reservoir.

Other CUP Projects--The Argenta Reservoir, with a capacity of 60,000 acre-feet, is planned for upper Big Cottonwood Canyon as storage for its waters and some diverted waters from Little Cottonwood Canyon. The construction of a small reservoir in Dry Creek holding 50,000 acre-feet, to which water from Little Cottonwood Canyon will be diverted, has also been considered.

Army Corps of Engineers Projects--

The South Pacific Division of the Army Corps of Engineers is working on projects which fall into three broad categories: navigation, flood control and multiple purpose.

The only navigation project underway in the area is a feasibility study for providing improvements on Great Salt Lake near Garfield for the benefit of recreational boating.

One flood control project has recently been completed on the Jordan River. The project included increasing the channel capacity of the Surplus Canal by excavation and levees for approximately seven miles from the mouth of the Jordan River to Goggin Drain, plus modification of the existing structure at the head of the Surplus Canal.

The Little Dell project in Mountain Dell is a multi-purpose reservoir which will have a capacity of 50,000 acre-feet. Preconstruction planning was initiated in June 1970. The project is slated to help prevent flooding in Salt Lake City and provide fishing and other recreational benefits.

An investigation of the Jordan River and its tributaries is also underway to improve conveyance of storm water to the Great Salt Lake. The initial phase of the plan will provide channel improvement through enlargement. The second phase will increase the storage facilities on City Creek, Big Cottonwood Creek and the Jordan River.

Jordan River Parkway--

In 1971, a study was conducted by Salt Lake County (Reference 8-2) to investigate alternatives to channelization of the Jordan River for flood control purposes. The study report recommended the creation of a park within the flood plain and development of the river for recreation. The recommendations were accepted by the County and as a result, a governmental agency, the Provo-Jordan Parkway Authority, was established to oversee the parkway development.

The parkway will include an area bordering the Jordan River from the Jordan Narrows to Farmington Bay and the lower reaches of the Provo River. Figure 8-3 presents a cross-sectional view of the Jordan River concept. The park will focus on the natural qualities of the river with bank terracing and landscaping designed to enhance aesthetic values and recreation potential. Land and water rights acquisition for the parkway is presently in progress.

Coordination of the water quality management plan with the plans for the Provo-Jordan Parkway is vital to the success of both endeavors.

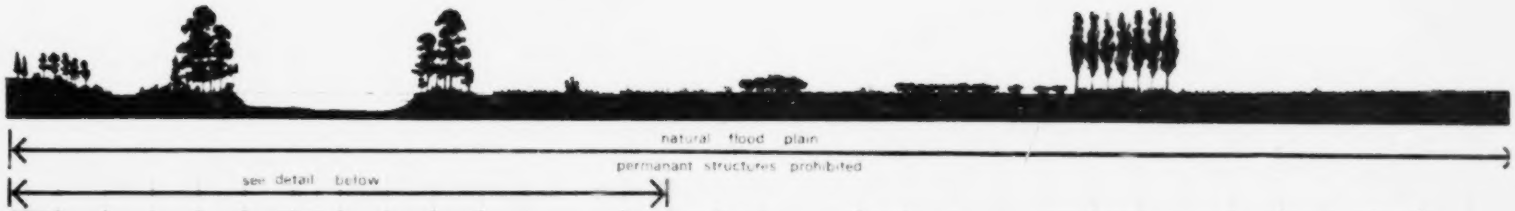
An urban river offers a city, fortunate enough to be endowed with such a waterway, an unparralleled opportunity for creating a pleasant and human-scale water-oriented urban environment. Few people can have visited Cambridge, England or San Antonio, Texas without realizing the contribution that even a small waterway can make to a humane environment. Yet this is an opportunity frequently lost.

As part of the present water quality management planning program, the people of the Salt Lake Valley are faced with a crucial choice. Should the Jordan River remain a conduit for the Valley's wastes, neglected, rarely glimpsed between factories; or should steps be taken toward a truly beneficial multi-use urban waterway?

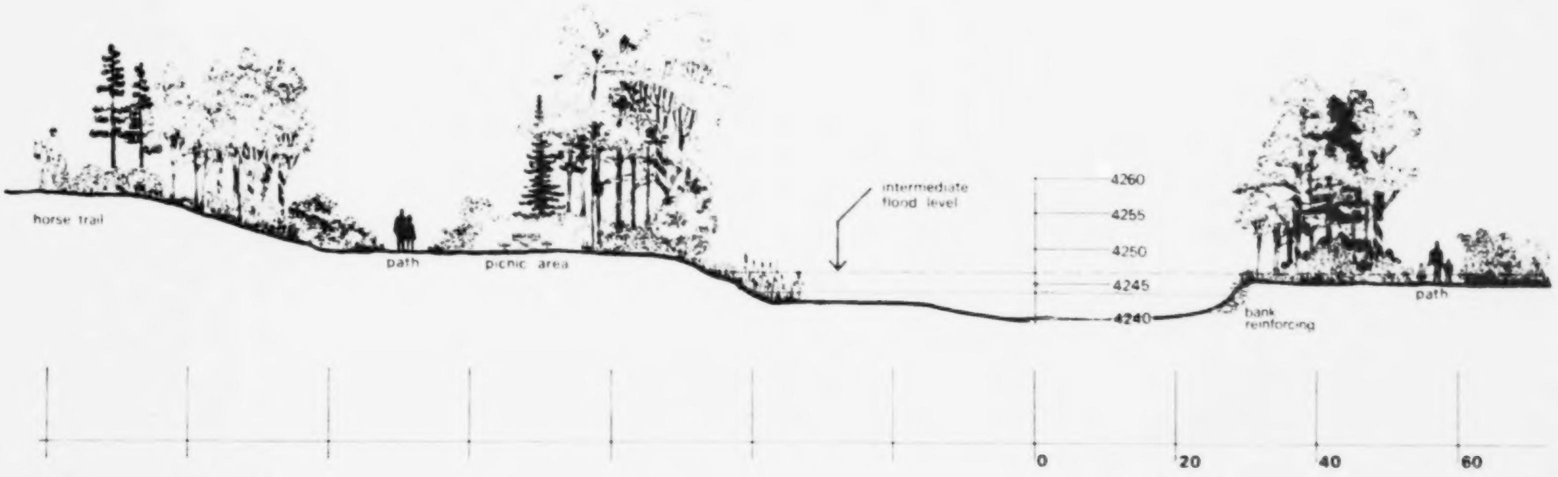
Decisions to be made in the next few years will determine the role the Jordan River will play in the lives of the next generation of Salt Lake Valley's residents. The opportunity exists to transform the presently undistinguished and under-used channel into a major asset to the urban community, not only supporting the needs of agriculture and industry but also providing for recreation and aesthetic enjoyment. The first steps toward this goal were taken by the Utah Legislature in approving the Provo-Jordan River Parkway concept. The next step could be selection of a wastewater management system that will enhance stream water quality.

Water Resource Development - Utah County

Utah County has the largest quantity of fresh water in the study area. A total of 120 miles of streams drain its 1,318 square mile catchment area. The mean annual discharge from the streams is 674,370 acre-feet.


natural flood plain
permanant structures prohibited
see detail below

section thru flood plain


horse trail
path
picnic area
intermediate flood level
4260
4255
4250
4245
4240
bank reinforcing
path
0
20
40
60

detail of riverbank

Urban Technology Associates

TYPICAL CROSS-SECTION OF THE JORDAN RIVER PARKWAY

FIGURE 8-3

In addition, its major lakes and reservoirs impound 885,929 acre-feet and cover 96,123 acres. The major portion of this water, 883,900 acre-feet, is retained within Utah Lake, covering 96,000 acres. Because of impaired water quality, not all of these resources are practical to develop. To meet 2020 demands, water will be imported by the Central Utah Project.

Central Utah Project--

Water released from the power plants in the Diamond Fork Power System to Diamond Fork Stream will be stored in the proposed Hayes Reservoir. The reservoir will be located a half mile from the confluence of Diamond Fork with Spanish Fork and will have a capacity of 51,500 acre-feet, covering an area of 680 acres. Day-use facilities for boating and picnicking will be constructed near the reservoir.

An enlargement of the existing Mona Reservoir in Northern Juab County on Currant Creek has been proposed. The enlarged capacity would be 47,000 acre-feet, and the impoundment would cover 3,000 acres. It is planned primarily as an irrigation reservoir, but facilities for boating and limited camping would be constructed. The Elberta Canal would carry stored waters for irrigation.

Reduced evaporation in Utah Lake is planned by diking Provo Bay and Goshen Bay from the main body of Utah Lake to eliminate these shallow areas. The Provo Bay dike would separate the eastern extremity of the lake with an earthfill dike 20 feet high. The bay would cover approximately 9,000 acres. The Goshen Bay dike, consisting of an earthfill 31 feet high would separate the southern portion of the lake. The Mosida Canal, running along the northwest side of Goshen Valley, would supplement irrigation needs in the Mosida area by pumping water from the main body of the lake to the canal.

The Beer Creek dike has been proposed to prevent flooding of Beer Creek below Spanish Fork by the fluctuating level of Utah Lake. The purpose of the Beer Creek pumping plant would be to collect drainage water from the inland side of the dike and pump to Utah Lake. Beer Creek Dam would divert the natural flow of Beer Creek around the west end of the dike back into the Beer Creek channel and then into Utah Lake.

Several other canals and aqueducts are proposed to carry irrigation waters from various Bonneville Unit projects. In addition to existing river and stream channels, the Wasatch Aqueduct, Mona-Nephi Canal and Nephi-Sevier Canal would convey water from the power plants and reservoirs in Diamond Fork to lands in Utah, Juab, Millard, Sanpete and Sevier Counties. The Mona-Nephi Canal would continue south from York Ridge to Nephi. During off-season times, some water would be released from the Mona-Nephi Canal for storage in Mona Reservoir. During irrigation periods, the water would be returned to the canal. At Nephi, water would be transferred from the Mona-Nephi Canal to the Nephi-Sevier Canal and then to the Sevier Bridge Reservoir.

Army Corps of Engineers Projects--

The only project in Utah County in which this agency is involved is a flood control project on the lower Spanish Fork River. The plan of improvement includes upgrading the river channel and constructing levees from the mouth of the river at Utah Lake upstream to the county bridge northwest of the Town of Spanish Fork. The channel improvement program would encompass 8.7 miles of stream. The project has been classified "deferred" because of lack of interest at the local level.

Water Resources Development--Wasatch County

Wasatch County contains considerable surface water resources, both in streams and reservoirs. There is a total of 102 miles of streams discharging in excess of 34,000 acre-feet per year. Deer Creek Reservoir's storage capacity accounts for 99 percent of the total of 153,173 acre-feet of stored water in Wasatch County. The reservoir covers 2,710 acres.

Groundwater measurements indicate that each year approximately 11,000 acre-feet of water from the underground water is added to the Provo River. The water level observable in the many wells that have been drilled in Heber Valley indicates that the water table is near the surface of the ground in the western part of the valley but that it tends to increase in depth in the eastern part of the valley where sediments from Daniels Canyon have increased the elevation of the land surface.

Central Utah Project--

The summarization of Central Utah Project plans within Wasatch County includes diversion of upper Stillwater Reservoir waters on Rock Creek

(Duchesne County) via the Stillwater and Hades Tunnels to the Rhodes Tunnel (Wasatch County). The West Fork pipeline then will carry the combined flow of Rhodes Tunnel, plus water from the West Fork Duchesne River, to the Strawberry Aqueduct, which then will transfer it to the Currant Creek Reservoir. Water from this reservoir will be transported through the Currant, Layout and Water Hollow Tunnels to the enlarged Strawberry Reservoir, which is the heart of the Central Utah Project. Its size will be enlarged to four times its present capacity, resulting in a storage of over one million acre-feet. The enlarged reservoir is planned as a multiple-use facility.

Development plans in Northern Wasatch County include upstream reservoir stabilization on streams in Summit County which feed the upper Provo River and construction of Jordanelle Dam. Jordanelle Dam and reservoir is planned for the Provo River six miles north of Heber City. It will have a storage capacity of 320,000 acre-feet and will have a backwater effect, extending 3.2 miles to the north. The reservoir will cover 3,068 acres and is planned as a multiple-use facility with a high degree of recreational potential.

IMPACT OF PROPOSED WATER RESOURCE DEVELOPMENT ON WATER QUALITY MANAGEMENT

Although a detailed assessment of the impact on water quality of all proposed water resource development projects is beyond the scope of this study, several general conclusions can be drawn.

Water quality in the study area will be affected by the importation of increased quantities of water from the Unita Basin in two ways. Larger quantities of water will be available for augmentation of stream flows, leading to increased capacity to assimilate wastes. Water quality will improve due to blending with imported high-quality waters.

Beginning in the headwaters of the basin, one large reservoir and the enlargement of a second is planned in Wasatch County for storage of water from the Central Utah Project. Few problems are expected in maintaining high levels of water quality in these reservoirs if land use within the watersheds can be controlled. Because continuous flow in the Upper Provo River will be maintained by controlled releases from the proposed Jordanelle Reservoir, its potential as an aquatic habitat should be enhanced. Strawberry Reservoir is being enlarged.

In Utah County, water quality in the Provo River and Diamond Fork will be improved by releases of water from Deer Creek and Strawberry Reservoirs.

Proposals to modify the character of Utah Lake by the Central Utah Project will have a significant impact on water quality in the lake. Provo Bay will be converted to agricultural land and Goshen Bay will be transformed into a salt marsh/bird refuge environment that will act as a sink for salts. A study conducted for the Department of the Interior in 1973 (Reference 8-3) included prediction of water quality in Utah Lake that would result from a number of different water quality management strategies. The assumption was made that the Central Utah Project would be implemented. The study indicated that the total dissolved solids content of the outflow from the lake into the Jordan River could be expected to decline approximately 30 percent by the year 2000 as a result of the Central Utah Project.

Bradshaw, et.al (Reference 8-4) concluded, however, that diking Provo Bay may aggravate water quality problems in Utah Lake because waters entering the lake from Hobble Creek and Mill Race Creek, carrying heavy pollutant loads, will no longer receive the benefit of the natural purification system that exists in Provo Bay at the present time.

In addition to the benefits of decreased salinity, water from the Central Utah Project offers a potential for low flow augmentation of the Jordan River. The impact on water quality of the proposed reservoirs on the Jordan River is difficult to estimate. Despite the fact that discharge of municipal wastes to the river occurs downstream of the proposed reservoirs, nutrient levels in the reservoirs will be sufficiently high to cause nuisance blooms of algae. The creation of a Jordan River Parkway, although it may not affect water quality directly, will increase the potential for water contact recreation and, in turn, the demand for high-quality waters in the Jordan River.

Further detrimental effects of the Central Utah Project will possibly result from the urbanization and increased industrial and agricultural activities that the project will allow.

REFERENCES

8-1. "State of Utah Water," Utah State Department of Water Resources," 1972.

8-2. "Jordan River Parkway - An Alternative, "Urban Technology Associates, 1971.

8-3. Walter, W.R., T.L. Huntzinger and G.V. Skogerboe, "Coordination of Agricultural and Urban Water Quality Management in the Utah Lake Drainage Area", Colorado State University, 1973.

8-4. J.S. Bradshaw, R.B. Sundrud, D.A. White, J.R. Barton, D.K. Fuhriman, E.L. Loveridge and D.R. Pratt "Chemical Response of Utah Lake to Nutrient Inflow, JWPCF, May 1973.

CHAPTER 9

WATER QUALITY STANDARDS AND CONTROL STRATEGIES

Water pollution is a manifestation of a phenomenon that a noted biologist describes as the tragedy of the commons (Reference 9-1). Each herdsman using the common pasture land will increase the size of his own flock in order to increase the benefits he derives from animal husbandry. Eventually the land is overgrazed and all the herdsmen suffer. A free resource inevitably becomes an overused resource in a society where each individual is free to pursue his own best interests without restraint. The rational man finds that his share of the disbenefit caused by discharge of his wastes to the common stream is less than the cost of treating the wastes before releasing them. Since this is true for everyone, the stream waters will become overused as a disposal medium unless the freedom to pollute is restricted.

The tragedy of the commons as applied to water quality may be averted by laws or taxation devices that alter the economic context such that it becomes cheaper to treat wastes than to bear the consequences of discharging the wastes untreated. In this regard, Utah has long had a dynamic water pollution control program. In 1972, the State's promulgation of water quality classification for all surface waters in the State was subsequently supported by the 1972 amendments to the Federal Water Pollution Control Act which established as a national goal the elimination of discharge of pollutants by 1985.

ATTAINMENT OF GOALS

In the case of water pollution, definition of the problem represents only a small step toward a solution. In view of the complex nature of the problem, how can progress be made toward the goal of environmental enhancement? To use a military analogy, a campaign strategy must be developed that will provide direction for the many tactical encounters necessary to win the war.

The main thrust of the strategy is contained in three activities: identification of the beneficial uses that a water body must sustain, determination of the level of water quality required to support these uses, and regulation of waste discharges such that this level of water quality can be attained. This strategy is embodied in the on-going

Federal and State water pollution control programs. The water quality management plan will provide information and recommendations to guide these continuing programs.

WATER QUALITY CONTROL PROGRAMS

Many government agencies, federal, state and local, are involved in the regulation of water quality. At the federal level the U. S. Environmental Protection Agency is charged with the responsibility for implementing the provisions of both the Federal Water Pollution Control Act as amended in 1972 and the National Environmental Policy Act of 1969 and for administering the federal construction grant program for wastewater facilities.

Within the State of Utah the State Division of Health, the State Board of Health and the Utah Water Pollution Committee have primary responsibility and authority to prevent waste disposal practices from becoming a hazard to health or a detriment to water quality.

Local agencies, industries and individuals are obliged to finance, build and operate wastewater facilities that will provide an acceptable means of waste disposal and meet all applicable water quality standards.

FEDERAL LEGISLATION

Legislation Prior to 1972

The history of Federal Water Pollution Control Legislation is described succinctly in a recent EPA publication (Reference 9-2) and is quoted extensively in the following paragraphs.

> "The first comprehensive Federal Water Pollution Control Act was enacted in 1948 on a temporary basis and extended in 1952. It became permanent legislation in 1956 and was amended in 1961 to establish a more effective program to abate pollution of navigable as well as interstate waters which endangered the health or welfare of persons. The method of enforcement was a Federal-State enforcement conference, with participation by local officials and other interested persons, to discuss pollution problems of a particular location and to make recommendations about those problems. Public hearing and court action followed the conference if the recommendations were not followed.
>
> In 1965, the FWPCA was again amended, this time by the Water Quality Act. Under it each of the States, the District

of Columbia, Puerto Rico, the Virgin Islands and Guam were given the opportunity for the first time under Federal law to establish water quality standards for interstate waters including coastal waters. If a State did not set such standards, the Federal Government did.

Water quality standards were set by classifying bodies of water for different levels of water use such as drinking, industrial water supply, or recreational use. Then the characteristics or criteria which the water had to have to support these uses were specified. A third part of the standards was the plans established to implement and enforce the criteria. When approved by the Federal authority, such standards (criteria and plans) became the Federal-State standards applicable to those waters.

Any discharge which reduced the quality of the receiving water below the criteria or in violation of an implementation plan was subject to enforcement action. States have always had the primary responsibility for enforcing water quality standards; but, because standards were federally approved and enforceable, the Federal government could enforce them by bringing an abatement suit, after at least 180 days' notice of violation to the dischargers and other interested parties.

Even earlier than the 1948 FWPCA, Congress passed the River and Harbor Act for the protection of the Nation's navigable waterways. Enacted in the late 1800's, this Act provided for the maintenance, protection, and preservation of the navigable waters of the United States, including regulation by means of permits for construction, dredging, and discharges in those waters. Section 13 of the River and Harbor Act of 1899, which by itself is known as the Refuse Act, literally prohibited the discharge or deposit of refuse matter into navigable waters and their tributaries unless authorized by a permit from the Secretary of the Army. The River and Harbor Act also provided enforcement measures, civil and criminal penalties, against any discharger of refuse who had not obtained a permit. Navigable waters, to which the River and Harbor Act applies, are those waters which are presently, or have been in the past, or may be in the future susceptible for use for purposes of interstate or foreign commerce.

The Refuse Act, as a section of an Act generally intended to prevent impediments to navigation, was initially used for navigational purposes. In recent times, with rising concern about increased water pollution, the potential use of the Refuse Act for water pollution control was recognized. With a focus on the discharge itself, it was seen as an enforcement tool complementary to the enforcement provision of the FWPCA, which focused on the quality of the receiving water. The Refuse Act could be used to enforce water quality requirements.

In 1970, the Department of the Interior, then charged with administering the water pollution control program, announced that the Refuse Act would be utilized more fully, and

> the Department of Justice issued guidelines for Refuse Act prosecutions against dischargers without permits. The Department of the Army announced its desire to initiate a Refuse Act Permit Program. Finally, by Executive Order on December 23, 1970, the President directed the establishment of a Federal permit program utilizing the Refuse Act, and requiring close coordination between the Army Corps of Engineers and the Environmental Protection Agency to which Federal pollution control activities had been transferred in early December 1970. Effective July, 1971, the discharger of any industrial wastes into navigable waters or their tributaries was required to have applied for a permit from the Corps."

THE FEDERAL WATER POLLUTION CONTROL ACT AMMENDMENTS OF 1972

The 1972 Amendments to the Federal Water Pollution Control Act replaced the language of the existing Act entirely, including the Water Quality Improvement Act of 1970, all of which had been amendments to the Federal Water Pollution Control Act.

The 1972 Act establishes as a national goal that the discharge of pollutants into the navigable waters of the United States be eliminated by 1985, and that, as an interim goal, wherever attainable there be achieved by July 1983 water quality which provides for the protection and propagation of fish, shellfish and wildlife and provides for recreation in and on the water.

It is recognized by EPA that while the 1983 goal is an objective which carries with it defined, specific, enforcement machanisms, the 1985 goal is an ideal toward which Congress intended the country to strive. To reach these goals, the Act requires that waste discharges must be of specified, improved quality before released to the receiving water. To assure that the improved quality is attained, new authority is given to federal and state governments to fully develop a national permit system to regulate the quality of discharged wastes.

The Act stipulates that effluent limitations for point sources other than publicly owned treatment works shall require the application of the best practicable control technology not later than 1 July 1977 and the best available technology by 1 July 1983. Effluent limitations for publicly owned treatment works must be based on secondary treatment by 1 July 1977 and shall require the application of the best practicable technolgy.

by 1 July 1983. Best practible control technology is being interpreted by the U. S. Environmental Protection Agency as a treatment level somewhat greater than secondary treatment. The Environmental Protection Agency regulations defining a secondary treated effluent, effective as of 17 August 1973, are summarized in Table 9-1. The current but not final definition of best practicable control technology is as follows; secondary treatment for treatment plants that discharge into effluent limited stream segments and secondary treatment or whatever is required to meet stream standards for water quality limited segments. (Reference EPA In-house Program Guidance Memo, 26 March 1974).

TABLE 9-1

FEDERAL EFFLUENT QUALITY REQUIREMENTS

Parameter	Unit	Secondary Treated Effluent[a] Monthly Average	Secondary Treated Effluent[a] Weekly Average
Biochemical Oxygen Demand (five day)	mg/l	30	45
Suspended Solids	mg/l	30	45
Fecal Coliform	no/100 ml	200[b]	200[b]
pH		6.0 to 9.0	

[a] Federal Register, 17 August 1973.

[b] Geometric mean values.

The controversy surrounding the definition of best practicable wastewater treatment centers on the question of nitrification. The proposed definition requires a fairly high degree of nitrification at temperatures above 20°C. Below 20°C no nitrification requirement is proposed. In the study area, wastewaters due to the nature of the raw water source, rarely exceed a temperature of 20°C. In view of this fact, and the uncertainty surrounding the best practicable treatment definition, it was concluded that nitrification would not be mandatory in the study area as a result of Federal regulations.

The meaning of best practicable control technology as applied to industrial waste discharges is being investigated by EPA and defined on an industry-by-industry basis.

The Grant Program

Section 201 of the Act authorizes the administrator of EPA to make grants of up to 75 percent of the cost of construction of publicly owned wastewater facilities. Approval of a grant is contingent on the fact that the works be in conformity with a basin water quality management plan.

The Basin Plans

Section 303(e) of the Act requires that the State shall have a continuing water quality management planning process. This study is the first stage of the planning process in the Utah Lake-Jordan River Hydrologic Basins. The plan will provide the information necessary to determine construction grant priorities and to provide a schedule for the effluent limitation or permit program.

The Permit Program

The new permit system set up under the Act is called the National Pollutant Discharge Elimination System (NPDES). It is a nationwide system and involves both Federal and State participation. The program in Utah is presently administered by EPA. Enabling legislation is required before the State of Utah can take over the NPDES program, however, the State staff is currently working closely with the Federal Government in administering the program.

STATE LEGISLATION

The Utah State Water Pollution Committee and the Utah State Board of Health are empowered by the State legislature to establish water quality criteria and enforce water quality standards in the State of Utah. These bodies have defined several classes or levels of stream water quality and have assigned classifications to all surface waters of the State. The assigned classifications are based on the cumulative effects of pollutants at the lowest point of the stream or drainage.

In addition the State has adopted an anti-degradation policy that requires that waters whose existing quality is better than that prescribed for its assigned classification will be maintained at that high quality unless it has been affirmatively demonstrated to the State that a change is justifiable as a result of necessary economic or social development and that it will not preclude present and anticipated use of the waters. A further provision is that wastes discharged to upstream waters under limitations imposed by a given classification shall be further controlled as required to protect water quality designated by all downstream classifications.

In June 1972, the Utah Water Pollution Committee and the Utah State Board of Health issued an order classifying all intrastate surface waters in the State as Class "C". Included in the Order was a schedule for compliance with the new water quality standards. The schedule required that all discharges must be altered, as necessary, to meet the standards by 31 December 1978. As an interim measure all dischargers must provide effective secondary treatment or the equivalent by 31 December 1974.

In early 1974, several modifications to the State standards were proposed. These modifications were adopted 4 June 1974. The dates for compliance with the secondary treatment requirements and the Class "C" standards were extended to 30 June 1977 and 30 June 1983, respectively. In addition, more stringent interim effluent standards were adopted that must be met by 30 June 1980.

Water Quality Standards

The Utah water quality standards are defined for six stream classifications, "A" through "E" and "S". Class "A" waters are to be protected against controllable pollution so as to be suitable without treatment for domestic water supplies, irrigation, stock watering, fish and wildlife propagation, recreation and as a source for industrial supplies. Physical, chemical, bacteriological and radiological standards are the same as the U.S. Public Health Service drinking water standards published in 1962. Class "B" waters are similar to Class "A" with the exception that the bacteriological standards for drinking water do not have to be met. The monthly mean coliform density should not, however, exceed 50 per 100 milliliters.

The standards for Class "C" waters are of paramount importance to the purposes of the water quality management plan and are consequently quoted verbatim from the Code of Waste Disposal Regulations. (Reference 9-3)

> "II-8. Class "C" Waters shall be so protected against controllable pollution, including heat, as to be suitable at all times for domestic water supplies which are treated before use by coagulation, sedimentation, filtration, and disinfection. Class "C" waters shall be suitable without treatment for aesthetics, irrigation, stock watering, propagation and perpetuation of fish, or aquatic life, and wildlife, recreation (except swimming), 1/ as a source of industrial supplies, and for other uses as may be determined by the committee and Board.
>
> It shall be unlawful to discharge or place any wastes or other substances in such a way as to result in:
>
> (a) Materials that will settle to form objectionable deposits;
>
> (b) Floating debis, oil, scum and other matters;
>
> (c) Substances producing objectionable color, odor, taste or turbidity;
>
> (d) Materials, including radionuclides, in concentrations or combinations which are toxic or which produce undersirable physiobiological responses in humans, fish and other animal life and plants;
>
> (e) Substances and conditions or combinations thereof which produce undersirable aquatic life; or
>
> (f) Other constituents which will interfere with the staged Class "C" water uses; or
>
> (g) The following specific standards being violated in any Class "C" waters:
>
> 1. Chemical and radiological standards shall be as prescribed for drinking water for 'Public Health Service Drinking Water Standards, 1962.'
>
> 2. Radioactive substances shall not exceed 1/30th of the MPC values given for continuous occupational exposure in National Bureau of Standards Handbook 69 or result in accumulations of radioactivity in edible plans and animals that present a hazard to consumers.
>
> 3. Hydrogen-ion concentration shall not exceed the range described by a pH of 6.5 to 8.5, nor shall it change more than 0.5 pH unit, from other than natural causes.

1/ In bodies of water where natural purification action can be shown to result in water quality consistent with the "CR" quality standard presented in Section II-II, swimming may be permitted subject to specific approval by the State Board of Health, notwithstanding any different initial classification.

4. Monthly arithmetical mean coliform density shall not exceed 5000 per 100 milliliters, as determined by standard multi-tube fermentation or membrane filter techniques; except that 20% of all samples collected in any month may exceed this standard if no more than 5% of all samples collected in the same month exceed a coliform density of 20,000 per 100 milliliters; AND, monthly arithmetical mean fecal coliform density shall not exceed 2000 per 100 milliliters.

5. Monthly arithmetical mean biochemical oxygen demand (BOD) shall not exceed 5 milligrams per liter, except that 20% of all samples collected in any month may exceed this value if no more than 5% of all samples collected in the same month exceed a BOD of 10 milligrams per liter.

6. Dissolved oxygen shall be not less than 5.5 milligrams per liter."

A number of subclasses for Class "C" waters have been defined to support additional desired uses. The "CR" recreation classification limits coliform density to 1,000 per 100 ml, the generally accepted bathing water standard, and the "CC" classification limits the temperature of discharges to a stream to support cold water fisheries.

Class "D" waters are to be protected as to be suitable for limited irrigation not to include irrigation of lawns, recreational areas, dairy cattle pastures, root crops or any low-growing crops produced for human consumption. The Class "D" standards are similar to those for Class "C" except that the monthly mean biochemical oxygen demand shall not exceed 25 mg/l.

The quality of Class "E" waters is to be protected to prevent health hazard or nuisance. Class "S" waters are to be protected as Class "A" except that specific waste discharges that do not interfere with the existing uses of the waters may be permitted by action of the Committee and Board. Such discharges are to be defined as to quantity, quality and duration.

The Anti-Degradation Policy

Waters whose existing quality is better than the established standards will be maintained at high quality unless it has been affirmatively demonstrated to the State that a change is justifiable as a result of necessary economic or social development and will not preclude present and anticipated use of such waters. Any industrial, public or private project or development which would constitute a new source of controllable pollution or an increased source of controllable pollution to high quality waters will be required to provide waste treatment to maintain high water quality to the extent that such treatment is practicable.

Effluent Requirements

Secondary treatment and interim effluent requirements have been promulgated by the Utah Water Pollution Committee and the Utah State Board of Health. These requirements are summarized in Table 9-2.

TABLE 9-2

SUMMARY OF STATE OF UTAH INTERIM EFFLUENT QUALITY REQUIREMENTS[a]

Paremeter	Unit	1977 Interim Requirements	1980 Interim Requirements
Biochemical Oxygen Demand (five-day)	mg/l	25[b]	10[b]
Suspended Solids	mg/l	25[b]	10[b]
Total Coliform	MPN/100 ml	2,000[c]	200[c]
Fecal Coliform	MPN or no/100 ml	200[c]	20[c]
pH		6.5 - 9.0	6.5 - 9.0

[a] Order before the Utah Water Pollution Committee, 4 June 1974

[b] Monthly arithmetic mean

[c] Monthly geometric mean

NOTE: A user of surface water diverted from waters of the State will not be required to remove any pollutants which the user has not added before returning the diverted flow to the original watercourse.

The stringent 1980 Utah interim requirements are based principally on the need to protect the public health. In order to understand the relationship between the limits for the effluent quality parameters shown in Table 9-2 and protection of the public health, it is necessary to describe its technical basis.

The main purpose of maintaining bacteriological water standards is to prevent the tranmission, to man, of pathogenic or disease-causing bacteria. For a number of reasons, it is difficult to test waters for the presence of micro-organisms of this type, on a routine basis, and consequently, tests are traditionally made for an indicator organism, the coliform bacteria.

Coliform bacteria such as the species Aerobacter aerogenes are widespread in the environment and can be found in the soil. Fecal coliform or Escherichia coli are found in the feces of warm-blooded animals, including man. Although fecal coliform bacteria do not cause disease, the presence of these organisms does indicate fecal contamination and the possible presence of pathogenic organisms of fecal origin. Statistical analysis of acceptable health risk allows the enumeration of fecal coliform standards for waters, based on the ratio of pathogens to fecal coliforms, that will adequately protect the public health.

The test for the presence of fecal coliform in waters is more difficult than the test for total coliform and hence, the later test has found more widespread application. Because coliform organisms emanate from sources other than feces, expressing bacteriological standards in terms of total coliform organisms provides a further margin of safety in the protection of public health.

Public health officials in Utah contend that because sewage effluents obviously contain fecal matter, the ratio of pathogens to coliform bacteria must be greater than that which prevails in the general environment. Hence, bacteriological standards for discharges of sewage effluent must be stringent and work toward the goal of complete elimination of coliform bacteria.

In order to produce treated wastewaters with low bacterial counts, it is vital that the effluents are effectively disinfected. Effective disinfection can only be accomplished when concentrations of suspended and organic materials in the effluent are low. Thus, the stringent 1980 effluent standards for suspended solids and biochemical oxygen demand content are designed to promote effective disinfection and a high degree of public health protection.

RELATIONSHIP BETWEEN STATE AND FEDERAL LEGISLATION

In general, State and Federal legislative activities complement each other. In cases of conflict, the more stringent requirement prevails.

One discrepancy in the legislative scenario is apparent, however. The Federal Water Pollution Control Act provides for the attainment of a level of water quality that will support fishing and swimming by

1983. In 1977, in contrast, there is no legislatively specified federal ambient goal although applicable local water quality standards must still be met. EPA has determined that generally these local water quality standards should provide for recreation on the water and protection of aquatic life.

In Utah, at this date, no surface water quality standards will be in effect. EPA has indicated that they may promulgate surface water quality standards that will apply for the period 1977 to 1983.

WATER QUALITY REQUIREMENTS

The beneficial uses that the surface waters in the basins must sustain are explicitly identified in the 1972 amendments to the Federal Water Pollution Control Act and in the State of Utah Class "C" standards. Each of these beneficial uses requires a certain level of water quality if it is to be uninterruptedly enjoyed. Frequently, requirements for different uses are in conflict and some compromise is necessary. Upstream use of a river by industries, for example, may prevent downstream use for recreational fishing. The function of water quality management is to resolve these conflicts and develop a strategy for maximizing the future benefits to be derived from the resource.

As a first step toward systematic management of water quality, a determination must be made of the concentrations of certain water quality parameters that correspond to the subjectively stated desirable level of water quality and that will support the identified beneficial uses.

Most people have a clear idea of what is "good" quality water; sparkling clear water, free from odors, free from floating debris, capable of supporting a diverse fish life--all these are considered desirable characteristics. Planning for water quality, however, requires the development of quantitative descriptions of "good" water, whenever this is possible. For example, the concept of "clear water" must be expressed in terms of a maximum allowable concentration of turbidity or suspended material; to support fish life, the water must contain more than a certain minimum concentration of dissolved oxygen.

Each of the desired uses of a stream or lake is associated with a set of water quality requirements that must be met if that use is to be sustained. Requirements for various beneficial uses are discussed in the following paragraphs.

Water quality requirements for maintenance of aquatic flora and fauna, for water-oriented recreation and for agricultural supply water apply directly to steam and impounded waters. The water quality needs for potable supply to communities and industries may be satisfied to some extent by treatment of water withdrawn from streams. However, a certain level of water quality must exist in the source waters if these beneficial uses are to be supported without resorting to costly advanced treatment methods.

Domestic Water Supplies

The U. S. Public Health Service Drinking Water Standards (Reference 9-4), the basis for all state standards for domestic water supply, are designed to protect the health and well-being of the public. Because the alteration of water quality by the application of conventional water treatment process (chemical coagulation, sedimentation, and filtration) is limited to only a few constituents, it is apparent that raw water of a certain quality is essential if the drinking water standards are to be met. Recognition of this fact in Utah has led to the U. S. Public Health Service Drinking Water Standards shown in Table 9-3 for the chemical quality of raw waters used for domestic supply.

Industrial Water Supply

Water quality requirements for industrial use are as diverse as the products manufactured. For some uses, such as high pressure boiler feed water, requirements are more stringent than the potable water standards, whereas water for cooling, for example, need not be of particularly good quality. In general the more highly specific industrial water quality requirements are met by pretreatment of municipal supply water by the industries themselves. Where the need for large quantities of lower quality water exists, supplies are frequently withdrawn directly from wells or surface waters. However, a certain level of raw water quality must prevail if high pretreatment costs are to be avoided.

TABLE 9-3

U. S. PUBLIC HEALTH SERVICE DRINKING WATER STANDARDS

RECOMMENDED

Substance	Concentration in mg/l
Alkyl Benzene (Sulfonate(ABS)	0.5
Arsenic (As)	0.01
Chloride (Cl)	250.
Copper (Cu)	1.
Carbon Chloroform Extract (CCE)	0.2
Cyanide (CN)	0.01
Fluoride (F)	(See 5.23)
Iron (Fe)	0.3
Manganese (Mn)	0.05
Nitratel (NO_3)	45.
Phenols	0.001
Sulfate (SO_4)	250.
Total Dissolved Solids	500.
Zinc (ZN)	5.

MANDATORY

Substance	Concentration in mg/l
Arsenic (As)	0.05
Barium (Ba)	1.0
Cadmium (Cd)	0.01
Chromium (Hexavalent) (Cr^{+6})	0.05
Cyanide (CN)	0.2
Fluoride (F)	(See 5.23)
Lead (Pb)	0.05
Selenium (Se)	0.01
Silver (Ag)	0.05

From the standpoint of extablishing stream water quality standards that will allow beneficial use by industry, it is reasonably safe to assume that maintenance of water quality suitable for domestic supply, after conventional treatment, will satisfy the needs of most industries.

Agricultural Water Supplies

With few exceptions agricultural water supplies are withdrawn from the surface streams and reservoirs and from groundwater aquifers and used without treatment. Thus, to support agricultural beneficial uses, stream water quality must be directly suitable for both livestock watering and crop irrigation. In general, raw waters that are suitable for domestic supplies are also adequate for agricultural use, if they are not softened or contain unusually high sodium concentrations. Soil permeability and structure are adversely affected when irrigated with water in which the ratio of sodium to calcium and magnesium salts is high. Most crops are seriously damaged by waters containing boron. Critical concentrations of boron for various crops range from 0.3 to 4 mg/l. A few crops are susceptible to high chlorine concentrations in the irrigation water. An important water quality parameter for irrigation use is the concentration of total dissolved solids (TDS). The particular combination of TDS and sodium adsorption ratio of a given water determines the suitability of that water for irrigation purposes.

A detailed description of the standard classification of water supplies for irrigation use is given in the classical work by Wilcox (Reference 9-5). A summary of the quality criteria and limits of concentrations of various constituents for irrigation use is presented in Table 9-4.

The criteria for irrigation water have limitations in actual practice. In many instances, water of a given quality may be wholly unsuitable for irrigation under certain conditions of use, yet be completely satisfactory under other circumstances. Soil permeability, drainage, temperature, humidity, rainfall, and other conditions can alter the response of a certain crop to a particular quality of water.

Due to the relatively low annual rainfall in the study area, waters of poor quality (Class 2 and some types of Class 3 waters) may cause moderate to severe unjury to the crops. Local agricultural experiment stations are in the best position to adjudge the suitability of a particular quality of water for a given soil-crop combination.

TABLE 9-4

SUMMARY OF IRRIGATION WATER QUALITY STANDARDS

Parameter	Class 1 Excellent to Good	Class 2 Good to Injurious	Class 3 Injurious to Unsatisfactory
Total dissolved solids, mg/l	<700	700 to 2,000	>2,000
Conductivity, micromhos/cm at 25°C	<1,000	1,000 to 3,000	>3,000
Chlorides, mg/l	<175	175,to 350	>350
Sodium, percent of base constituents	<60	60 to 75	>75
Boron, mg/l	<0.5	0.5 to 2.0	2.0

Water quality requirements for livestock use are similar to, although less stringent than, those for domestic use. Key water quality criteria for livestock use are shown in Table 9-5 (Reference 9-6).

TABLE 9-5

KEY WATER QUALITY CRITERIA FOR LIVESTOCK USE

Characteristic	Recommendations
Total dissolved solids (TDS)	10,000 mg/l, depending upon animal species and ionic composition of the water.
Hazardous trace elements:	
Arsenic	0.05 mg/l
Cadmium	0.01 mg/l
Chromium	0.05 mg/l
Fluorine	2.40 mg/l
Lead	0.05 mg/l
Selenium	0.01 mg/l
Organic substances:	
Algai (water bloom)	Avoid abnormally heavy growth blue-green algae.
Parasites and pathogens.	Conform to epidemiological evidence.
Dissolved organic compounds.	Biologial accumulation from environmental sources, including water, shall not exceed established, legal limits in livestock products.
Radionuclides	Conform to recommendations for farmstead water supplies.

Recreation

Water-oriented recreation includes activities that involve varying degrees of contact with the surface waters. Water quality requirements for body contact sports such as swimming are higher than those for boating or aesthetic enjoyment. The quality criteria for the latter activities are simply freedom from objectionable flotsam, color or odor. If the recreation activity involves the possibility of ingestion of water, a certain level of bacteriological water quality must be maintained to protect the public health. Compliance with the generally accepted bathing water bacteriological standard of less than 1,000 coliform organisms per 100 milliliters (Reference 9-7), requires a higher level of water quality than that generally required for municipal raw water sources. Utah's Class "C" standard of 5000 coliform organisms per 100 milliliters does not provide for bathing.

For secondary contact recreation--activities not involving significant risks of ingestion--requirements are somewhat more relaxed. Fecal coliform density should not exceed a log mean of 1,000 per 100 ml for such uses (Reference 9-6).

Propagation of Fisheries and Wildlife

Fish and aquatic life can exist in waters of many different qualities. A change in water quality will, however, result in a change in the numbers and species composition of the aquatic community. The minimal goal of water quality criteria for fish and aquatic life conservation is to define a level of water quality that will support a balanced aquatic flora and fauna similar to that which might exist in the stream if it were unaffected by man's activities.

Some of the individual requirements are: dissolved oxygen content should be greater than 5 mg/l, pH should be between 6 and 9 and free carbon dioxide content should not exceed 25 mg/l (Reference 9-6 and 9-8). Establishing an acceptable ammonia concentration that well protect fisheries is more difficult. It has been demonstrated that an un-ionized ammonia is the toxic agent and that no adverse effects on aquatic life are evident at concentrations of less than 0.025 mg/l as ammonia (Reference 9-9). The ratio of un-ionized ammonia to total ammonia depends on water temperature and pH. Assuming a water temperature of 20°C, the total ammonia-nitrogen concentration that corresponds to this limit is 5.2 mg/l at pH 7.0 and 0.54 mg/l at pH 8.0. Thus, a standard of 0.5 mg/l is desirable.

Many substances produced by man's activities are toxic to fish and aquatic life and destructive to the aquatic habitat. These substances should be identified and their discharge to waterways prohibited if a productive aquatic environment is to be present.

CONTROL TACTICS IN THE UTAH LAKE-JORDAN RIVER BASIN

To provide a basis for planning, water quality criteria must be developed that incorporate the legislative requirements, including the antidegradation policy, and resolve the conflicting quality requirements for the various beneficial uses.

Water Quality Planning Criteria

Water quality planning criteria are stipulations, expressed numerically, where possible, that pertain to the quality of waters that are recommended for use in developing plans to implement water pollution control. Water quality planning criteria are distinguished from water quality standards by the fact that they are not legally enforceable.

The State of Utah Class "C" standards will provide the basis for planning in the study area; however, a number of supplementary planning criteria must be established to complete the planning base. Supplementary criteria and the Class "C" standards are best discussed in the context of the water quality problems their enumeration and enforcement is intended to cure. Recommended planning criteria for the basins are shown in Table 9-6.

Oxygen Depletion

Depletion of the dissolved oxygen content of surface water results from natural or man-made introductions of carbonaceous and nitrogenous material into the stream that, in the process of decay, exert an oxygen demand. Low levels of dissolved oxygen are inimicable to fish and other aquatic life.

The Class "C" standards approach the problem of oxygen depletion in two ways: a provision that surface water must have a biochemical oxygen demand of 5 mg/l or less is reinforced by a requirement that the dissolved oxygen content of the surface waters must not be reduced to less than 5.5 mg/l. For the purposes of water quality management, the latter requirement is more appropriate because dissolved oxygen content is a direct measure of the aquatic environment, whereas biochemical oxygen demand is an indicator of a possible, but not certain adverse environmental impact. Waters leaving Utah Lake, for example, paradoxically exhibit relatively high values in the range or 5 to 10 mg/l

TABLE 9-6

WATER QUALITY PLANNING CRITERIA FOR THE UTAH LAKE-JORDAN RIVER BASINS

Constituent	Limit	Classification
Dissolved oxygen, mg/l	5.5 6.0	Class "C" Class "CW" and "CC"
Fecal coliform, MPN or no/100 ml	200	EPA secondary treatment definition--see discussion
pH	6 - 9	Class "C"
Total dissolved solids, mg/l	500	Class "C" -- See discussion
Chemical constituents	U.S. Public Health Service Drinking Water Standards	Class "C"
Radiological constituents	U.S. Public Health Service Drinking Water Standards	Class "C"
Nutrients: Total Nitrogen Total Phosphorus	No increase over present concentrations	See discussion
Toxic materials	No toxic effects attributable to waste discharge	See discussion

of both biochemical oxygen demand and dissolved oxygen. The high biochemical oxygen demand appears to result from algae and resuspended organic material from the lake bottom and cannot be regarded as controllable pollutant in the generally accepted sense of the term.

Bacteriological Quality

The Class "C" standards stipulate that the monthly mean total coliform density in surface water must not exceed 5,000 per 100 ml. The compliance date for this requirement is 30 June 1983. Six years prior to this date, however, publicly owned wastewater treatment facilities must comply with the Utah and Federal secondary treatment effluent standard of 200 fecal coliforms per 100 ml. Because the principal sources of fecal coliforms are people and livestock, it is apparent that bacteriological water quality should improve to better than that specified in the Class "C" standards, if stringent controls are also effected on other sources as on municipal wastewater treatment plants. The recommended planning criteria are therefore a maximum of 200 fecal coliforms per 100 ml, which is generally taken to be equivalent to 1,000 total coliforms per 100 ml.

Salinity

The Class "C" standards recommend that the total dissolved solids content of surface water should not exceed 500 mg/l. The fact that Utah Lake and the Jordan River do not presently meet this standard is a result of both natural and man-made factors. Pollution sources from man's activities can be regarded as controllable; however, any attempt to bring these waters completely into compliance with the standards would involve large-scale changes in land and water use within the study area. As a consequence, the Class "C" TDS standard is retained for planning as a goal to strive for rather than an objective to be attained within the immediate future.

Biostimulation

Lakes are subject to a natural aging or succession process. A "young" or oligotrophic lake is characterized by clear water and sparse aquatic plants. As sediment and nutrients are washed into the lake, the waters become enriched and more turbid, algae and other aquatic plants flourish and the species of native fish change until finally the lake becomes a marsh or swamp. Under natural conditions this process, termed eutrophication, takes many thousands of years; however, the intervention of man may greatly accelerate it.

Attempts have been made to prevent accelerated aging or eutrophication of inland waters by controlling the input of nutrient materials to the water body. The problem is complicated by both the multiple sources of nutrients and the limited understanding of the relationship between nutrient concentrations in water and their potential for biostimulation.

Development of reliable quality criteria for waters to prevent biostimulation and nuisance growths of algae has proved problematical since many nutrients are required for plant growth and it is difficult to determine which nutrient is the controlling factor. Most attention has been focused on nitrogen and phosphorus as plant nutrients; however, many other substances such as carbon, iron or vitamin B_{12} may be the limiting factor in particular cases.

In Utah Lake and the Jordan River, total nitrogen and phosphorus concentrations exceed by several times those concentrations known to have supported nuisance algal blooms at other locations. With some local exceptions in Utah Lake bays and the lower Provo River, algal blooms are not presently a serious nuisance. It is recommended, therefore, that planning criteria be established that limit nitrogen and phosphorous concentrations in the surface waters to their present levels unless it can be demonstrated that increased concentrations will not cause increased algal blooms. Nevertheless, as a general policy active efforts should be made to reduce the quantities of nutrients discharged to the surface water.

It should be noted that algal growth is dependent on available light; it is conceivable that the turbid nature of Utah Lake and the Jordan River precludes major blooms at the present time. Some of the proposed water resource development programs, for example the Central Utah Project, if implimented, might result in a reduction in turbidity in these water bodies which in turn would cause algal blooms. If this proved to be the case, more stringent control of nutrient discharges would become necessary.

Water Quality Analysis

A critical tactical step in controlling water pollution in the study area is the investigation of the impact of different levels of waste control on water quality in the surface stream. What degree of waste treatment will be necessary to comply with water quality standards? Methods for the analysis of the cause and effect relationship between waste discharge and water quality are described in Chapter 11.

Classification of Stream Segments

The draft guidelines for 303(e) water quality management plans recommend that the surface streams be divided into segments and classified as a water quality class or effluent limitation class. Effluent limitation class segments are segments where water quality is meeting and will continue to meet applicable water quality standards or where there is adequate demonstration that water quality will meet the standards after application of secondary treatment to all publicly owned point sources and best practicable treatment to all industrial point sources. Water quality class segments are those where water quality does not meet the applicable standards and is not expected to do so even after application of the level of technology described above. Water quality class segments are to be further classified as Data Type I, segments for which data are sufficient to execute load allocations, and Data Type II, segments for which additional monitoring is needed to allocate loads.

The State of Utah, through submittal of its Section 303(e) continuing planning process has designated the waters of the entire basin "Water Quality Class, Data Type II." This means that there are reasonable doubts as to the designation in view of the paucity of relevent water quality data available at the time the designation was made. Water quality monitoring conducted as part of the water quality mangement study and the water quality analysis allows a more selective and knowledgeable analysis of stream segments, which is described in detail in Chapter 10.

Waste Load Allocations

A further recommendation pertaining to the analysis of water quality class segments is included in the draft guidelines for water quality management plans. A waste load maximum must be estimated for each water quality class segment that will allow compliance with the applicable water standards. The available assimilative capacity of the stream must then be allocated to existing competitive dischargers. The purpose of waste load allocation is to provide a basis for estimation of effluent limitations for individual dischargers as part of the permit program. In addition, waste load allocation will assist in the development of compliance schedules and priorities for treatment facility construction grants.

Effluent Limitations and Water Quality Standards

Until recently the State of Utah was assuming that dischargers must meet an effluent requirement of Class "C" or "D" water to meet an instream requirement of Class "C" or "D". In the absence of adequate water quality information this is clearly a practical approach, particularly in view of the recognized low levels of water quality prevailing in the downstream portions of the basins. The assumption that underlay this position was that no portion of the surface waters can be designated as a mixing zone for dilution of discharged waste, as well as the fact that only small quantities of dilution water are available at most discharge points.

As more data have become available, this position has been altered with regard to effluent concentrations of material exerting biochemical oxygen demand. The reasons for this are threefold. First, the Class "C" water quality standard of 5 mg/l biochemical oxygen demand,the basis for a similar effluent standard, is an unreliable guide to stream water quality as discussed in the previous section. The complementary water quality standard of 5.5 mg/l dissolved oxygen content is a better measure of water quality with respect to oxygen depletion. Second, few waste treatment process trains are capable of producing an effluent that would meet the Class "C" standard for biochemical oxygen demand. Those that do incur costs two to three times greater than conventional secondary wastewater treatment plant. Third, some measure of dilution in the receiving waters is a long accepted and effective method of meeting water quality standards, and its continued use is implied by the Environmental Protection Agency's adoption of a secondary treatment definition and a proposed definition of best practicable control technology that specify effluent limits for oxygen-demanding material several times greater than 5 mg/l. A conventional well-designed dispersion structure can achieve at least a fivefold dilution within ten feet of the structure if stream flow is sufficient to provide the required volume higher quality of dilution water (Reference 9-9). However, it should be emphasized that dilution alone is not an acceptable method for diminution of pollution effects until all economically practicable steps have been taken to eliminate the pollutants at their source.

In view of the high cost of complying with an effluent limitation of 5 mg/l biochemical oxygen demand and the limited degree of environmental enhancement that is likely to result from compliance in cases where adequate volumes of dilution water are available, it becomes desirable that the limitation be relaxed to a level equivalent to the interim effluent standards whenever it can be positively demonstrated that dilution can be achieved and no adverse environmental effects are likely.

Enforcement

The permit program (NPDES) is the principal mechanism by which effluent limitations are enforced. A strategy for the issuance of permits is described as part of the recommended plan in Chapter 14.

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CHAPTER 10

PRESENT WATER QUALITY

> "Darwinian fitness is compounded of a mutual relationship between the organism and the environment. Of this, fitness of the environment is quite as essential a component as the fitness which arises in the process of organic evolution; and in fundamental characteristics the actual environment is the fittest possible abode of life." (Reference 10-1)

The physical, chemical and biological characteristics of a body of water serve as an overall indicator of the fitness of an aquatic environment. Clearly the first step in a program of environmental enhancement must be characterization of that environment. What are the existing problems and where do they occur? A sampling and analyiss program was conducted as part of the planning study to answer these questions.

Stream and river characteristics vary with respect to concentration, composition and spatial distribution of substances. The smaller streams are greatly invluenced by seasonal variation in temperature and precipitation. The geochemical nature of the watershed imparts some individuality within the limited regions. This variability is evident not only when comparing different streams but also along the gradient of a particular stream. In this respect, edaphic factors, human intervention and channel morphology have marked influences.

The sampling program was designed to take account of these diverse factors and to provide the basis for an assessment of quality of surface waters within the basin.

WATER QUALITY CHARACTERIZATION

A number of agencies and organizations collect water and wastewater data in the study area. In most cases, these programs are designed with specific objectives: to determine wastewater treatment efficiency or compliance with water quality standards.

Water quality sampling and analytical programs have been or are being conducted by the U. S. Environmental Protection Agency, the Utah State Division of Health, the U. S. Geological Survey, the U. S. Forest Service, the various county health departments, the University of Utah, and Brigham Young University. The Utah Seate Division of Health and county health departments and the U.S. Geological Survey maintain sampling stations at key locations throughout the basin area for regular monitoring. The U. S. Forest Service conducts sampling within Forest Service boundaries. The University of Utah has monitored water quality in some Wasatch Front streams and Brigham Young University maintains sampling stations at various points on Utah Lake. All of the available water and wastewater quality data were collected and reviewed as part of this study. Additional data needs were identified and a supplementary sampling program was designed to obtain the necessary data.

Stream sampling stations were established to obtain supplementary water quality data. These stations were sampled monthly, bi-monthly or quarterly, depending upon the flow and quality characteristics of the stream. The frequency of measurement of a particular characteristic at a given sampling station was reduced when repeated measurements indicated that the concentration was less than the maximum allowed by the State Class "C" water quality standards. Some analyses were eliminated when it was shown that the constituent was absent or undetectable in the samples.

Biological water quality data have not been collected routinely by any agency; consequently, a faunal sampling program was established. Aquatic invertebrates were sampled, identified and counted as a further measure of pollution effects for twenty-six stations throughout the basins.

Municipal, industrial and agricultural wastewaters, irrigation return waters, and storm drainage all carry pollutants that degrade the quality of the receiving streams. The sampling program for these wastewaters was designed to provide the data needed to estimate the pollutant loads contributed by each wastewater source.

The routine operational records from each of the 27 municipal wastewater treatment plants in the study area were reviewed regularly. In addition, effluent samples were taken monthly for analysis. Monthly effluent samples were analyzed from industrial waste sources that discharge directly to streams in the study area. Flow data were obtained also for calculation of waste loads.

Sixty-three stations were established on canals and diversions throughout the study area to monitor agricultural runoff. Analyses were performed monthly during the growing season and quarterly at other times, except during the winter period when no flows were diverted into the canals.

Seventeen stations were established throughout the basin area to monitor urban storm runoff quality. Samples were taken from each drain during dry weather periods to provide "normal" or background data. In the rainy season, each storm drain station was sampled during the first storm of each month.

All water quality information gathered during the study was entered in the U.S. Environmental Protection Agency's water quality data bank, STORET. A summary is included in Appendix 10-A.

WATER QUALITY PROBLEMS

Information on surface water quality was evaluated in the context of a number of major water quality problems: oxygen depletion, nutrient enrichment, excess salinity, bacteriological contamination, toxicity, and biotic degradation. The analysis of water quality by stream is prefaced by a discussion of water quality problems, their causes, and the parameters used to measure them.

Oxygen Depletion

The concentration of dissolved oxygen in water is possibly the single most important physical or chemical factor in an aquatic ecosystem. The composition and productivity of the more desirable biological communities is a function of dissolved oxygen content. As the level of dissolved oxygen is depressed, only pollution-resistant organisms can survive.

The oxygen content of stream waters is reduced when excess carbonaceous - nitrogenous matter is introduced into the stream as a result of the process of decomposition by microorganisms. Heavy organic waste loads may result in exhaustion of dissolved oxygen and the development of septic or anaerobic conditions. The parameter used to measure organic load and its potential for oxygen depletion is biochemical oxygen demand.

The State of Utah Class "C" standards approach the problem of oxygen depletion in two ways: a provision that surface waters must have a biochemical oxygen demand of 5 mg/l or less is reinforced by a requirement that the dissolved oxygen content of the surface waters must not be reduced to less than 5.5 mg/l. As discussed in a previous chapter, the latter requirement is appropriate as a direct measure of the condition of the aquatic environment, whereas biochemical oxygen demand is an indicator of a possible, but not certain pollution.

Because of the Class "C" standard, the sampling program placed emphasis on the biochemical oxygen demand requirement. Consequently, an oxygen depletion problem is defined as a condition where stream water has biochemical oxygen demand in excess of 5 mg/l.

Nutrient Enrichment

All organisms need food to sustain life. The food or nutrient requirements of plants and animals are numerous and include sugars, proteins, vitamins, nitrogen, phosphorus, metals, and many other unknown growth factors. In an aquatic ecosystem, the abundance of nutrients determines the level of plant growth and, indirectly, the overall productivity of a system.

Nutrient enrichment is a problem of degree. Some nutrients are essential to life; however, when nutrient concentrations are increased by human intervention beyond needs, this enrichment becomes pollution.

Nitrogen and phosphorus often appear to be the limiting nutrient in aquatic systems and when present in excess, lead to uninhibited algal growth that results in reduced light transmittance, choked waterways, with eventual decomposition and oxygen depletion.

Water quality standards for nitrogen and phosphorus are not well established; the Class "C" standards contain no reference to nutrients. For the purpose of this study, a nutrient enrichment problem is associated with nitrate levels in excess of 0.5 mg/l and phosphate levels in excess of 0.05 mg/l.

Excess Salinity

Total dissolved solids are the non-filterable materials contained in water. As the total dissolved solids content or salinity of water increases, its suitability for many uses decreases. Salinity results from both natural and cultural factors.

The Class "C" standard for total dissolved solids is 500 mg/l, and this is used to identify excess salinity problems.

A list of the ions and minerals assayed in the sampling program and their mandatory or recommended limits for Class "C" standards is shown in Table 10-1.

Table 10-1

STATE OF UTAH
STANDARDS FOR DISSOLVED SOLIDS
(mg/1)

Ion	Class "C" Water Quality Standards Recommended	Mandatory
Cations		
Arsenic (As)	0.01	0.05
Barium (Ba)	-	1.0
Cadmium (Cd)	-	0.01
Chromium (Cr)	-	0.05
Copper (Cu)	1.0	-
Iron (Fe)	0.3	-
Lead (Pb)	-	0.05
Manganese (Mn)	0.05	-
Selenium (Se)	-	0.01
Silver (Ag)	-	0.05
Zinc (Zn)	5.0	-
Anions		
Chloride (Cl)	250	-
Cyanide (Cn)	0.01	0.02
Fluoride (F)	1.0	2.0
Nitrate (NO_3)	45	-
Sulfate (SO_4)	250	-
Total Dissolved Solids	500	-

Bacteriological Contamination

Fecal coliform bacteria are found in the intestinal tracts of warm-blooded animals including man. The presence of these bacetria in water is indicative of fecal contamination and the possible presence of disease-producing bacteria.

The State Class "C" standard limits the concentration of total coliform bacteria to 2,000 per 100 ml, and this served as a definition of bacteriological contamination.

Toxicity

Many substances may have a toxic effect on aquatic life. Ammonia, radioactivity, heavy metals and some pesticides and herbicides have been identified as hazards to aquatic life and ecological stability. The presence of these substances may lead to rapid death of organisms (acute toxic effects) or long-term impairment of their vital functions (chronic toxic effects).

The Class "C" standards do not directly address toxicity to aquatic life, although maintenance of the chemical standards shown in Table 10-1 should control toxicity to some degree.

Biotic Degradation

Aquatic communities are capable of supporting a great variety of bacteria, plant and animal life. Bacteria decompose organic and inorganic materials to elemental states, while small algae are important on the primary trophic level in energy-transfer relationships. Larger algae and "higher" plants provide food and cover for animal populations. Benthic invertebrates, such as insects and fishes, complete the aquatic system by occupying the secondary and tertiary trophic levels.

In an unpolluted system, variability again is often the key word. An optimum aquatic environment has pools, riffles, runs and shore variations which provide niches for many different kinds of organisms. Predation and competition for food and space form a delicate, complex relationship that generally limits the numbers of any given species. Invertebrates usually associated with this habitat include mayflies, stoneflies, caddis flies, hellgrammites and riffle beetles, all of which are valuable fish food resources.

Nutrient addition to a body of water may be beneficial as long as it does not exceed the assimilative capacities of the aquatic life present. As the enrichment exceeds assimilation, the physiochemical water quality becomes degraded. Organic pollution normally excludes sensitive organisms, leaving the more tolerant midges, leeches and sludge worms. Extreme organic pollution may manifest into sole communities of sludge worms and sewage fungus. Toxic elements, turbidity and heavy sedimentation or scouring can also greatly reduces benthic populations.

Benthic species composition serves as a good indicator of environmental "fitness." The presence of many different kinds of organisms shows a healthy, complex environment. One measure, incorporating numbers and kinds of organisms, is a diversity index such as Margalef's (Reference 10-2):

$$\text{D.I.} = -\sum p_i \log_e p_i$$

where p_i is the fraction of the total number of individuals in the sample in the i^{th} taxonimic category. Relatively poor areas exhibit a diversity index from 0.0 to 1.0. The more diverse populations will calculate greater than 1.0. It should be noted that this index provides a rough measure of benthic community structure. A full description would require consideration of biomass and total numbers of individual organisms.

PRESENT WATER QUALITY

The following section reviews water quality in Davis, Salt Lake, Utah and Wasatch counties. The major water quality problems discussed are biochemical oxygen demand, total dissolved solids, coliform, oil and grease, nitrates and phosphates. Biological data, where applicable, are discussed with stream situations. Table 10-2 presents a qualitative analysis of benthic organisms found in the fifteen stream survey; corresponding figures of "Benthic Diversity" are presented by County.

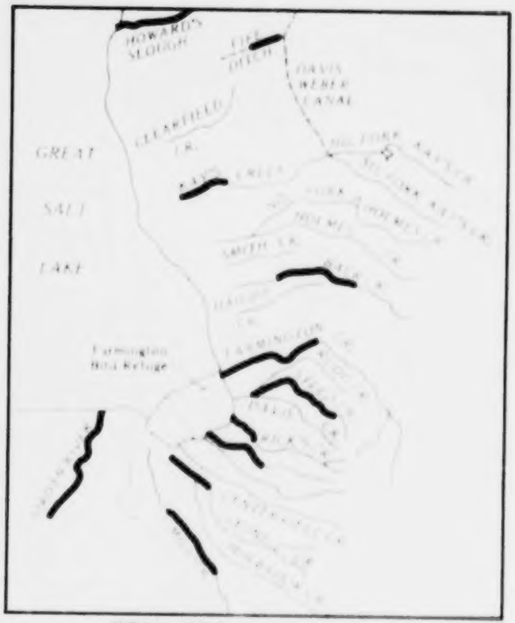
Davis County

In general the upper portions of streams flowing on the west side of the Wasatch Mountains in Davis County are of high quality. As the streams flow westward through rural and urban areas of the county, water quality deteriorates. Most waters in the western portion of the county draining to Farmington Bay do not meet Class "C" water quality requirements. Excess levels beyond these limits are shown in Figure 10-1.

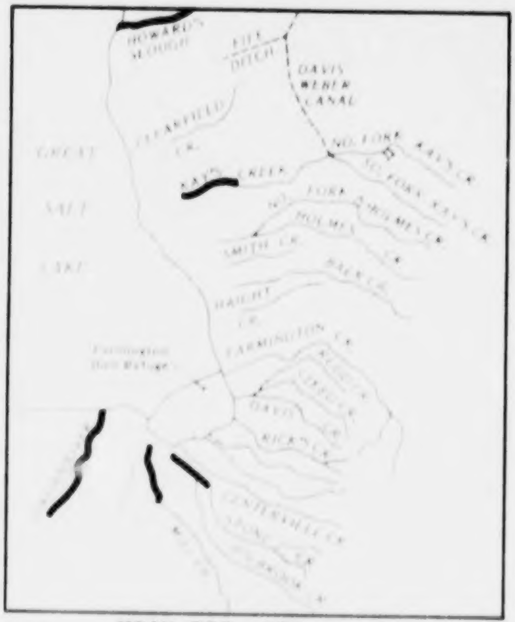
The combined drainage of Rudd, Steed and Davis creeks, sampled at their confluence, contains some organic matter resulting in biochemical oxygen demand (BOD) values in excess of 9 mg/l. A similar situation exists in the lower reaches of Holmes, Farmington, Ricks, Barnard and Smith creeks. Forest Service records indicate problems with total coliform as several streams leave Forest Service boundaries. Baer, Ward, Holmes, Farmington and Mill Creek all exhibit coliform values in excess of 22,000 MPN during the summer months.

Streams draining into the Salt Flat: Kay's, Holmes, Smith and Baer, all exhibited extensive nitrate concentrations along their lengths. Farmington, Stone, Holbrook and Mill creeks, which drain into Farmington Bay, show high nitrate levels with some high phosphate concentrations in Farmington and Stone creeks. Nutrient sources are probably agricultural and urban runoff.

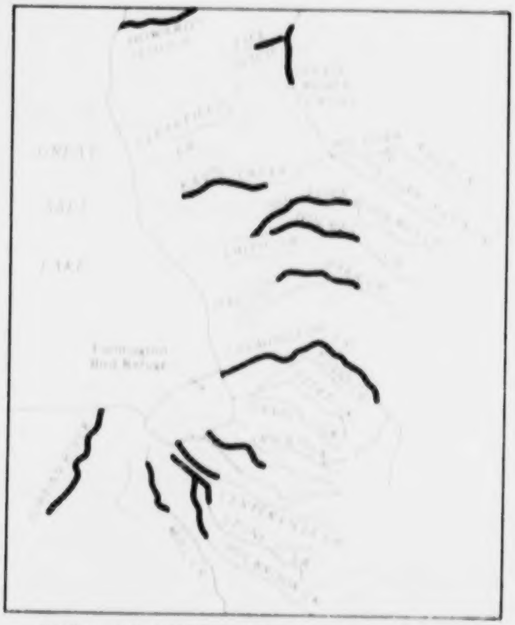
Davis County has few sources of radioactive wastes; however, radioactivity levels of 35 picocuries/liter were measured on the Jordan River 50 feet above the South Davis South treatment plant outfall in 1972. Twenty-seven picocuries/liter was also measured in the State Canal near the South Davis South treatment plant, and lesser amounts in the Central Davis treatment plant effluents.


HOWARD'S SLOUGH
FIFE DITCH
DAVIS WEBER CANAL
GREAT SALT LAKE
CLEARFIELD CR.
KAYS CREEK
NO. FORK HOLMES CR.
SMITH CR.
BAER CR.
HAIGHT CR.
FARMINGTON CR.
Farmington Bird Refuge
CENTERVILLE CR.

MEAN BOD > 5.0 mg/ℓ

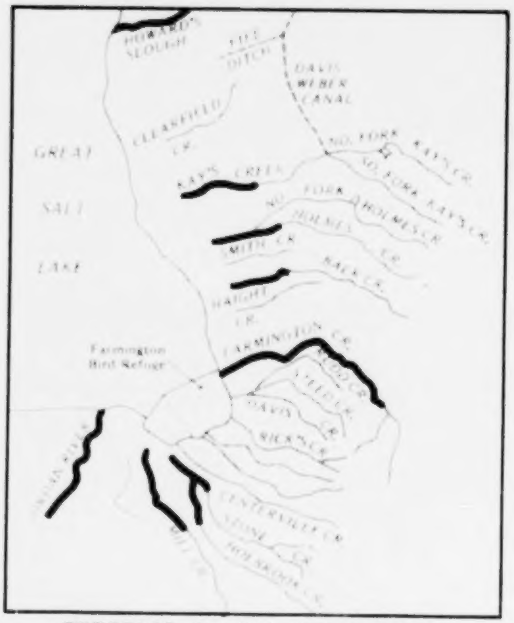

HOWARD'S SLOUGH
FIFE DITCH
DAVIS WEBER CANAL
GREAT SALT LAKE
CLEARFIELD CR.
NO. FORK KAYS CR.
KAYS CREEK
SO. FORK KAYS CR.
NO. FORK HOLMES CR.
HOLMES CR.
SMITH CR.
BAER CR.
HAIGHT CR.
FARMINGTON CR.
Farmington Bird Refuge
DAVIS CR.
RICKS CR.
CENTERVILLE CR.
STONE CR.
PARRISH CR.

MEAN TDS > 500 mg/ℓ

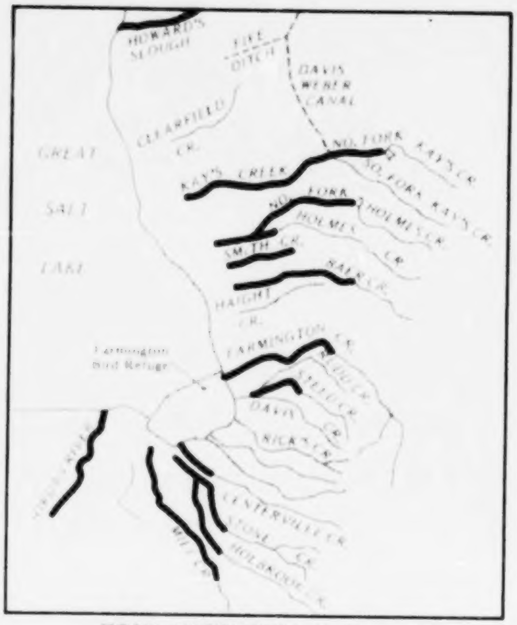

HOWARD'S SLOUGH
GREAT SALT LAKE
Farmington Bird Refuge

MEAN COLIFORM MPN 5,000/100 mℓ

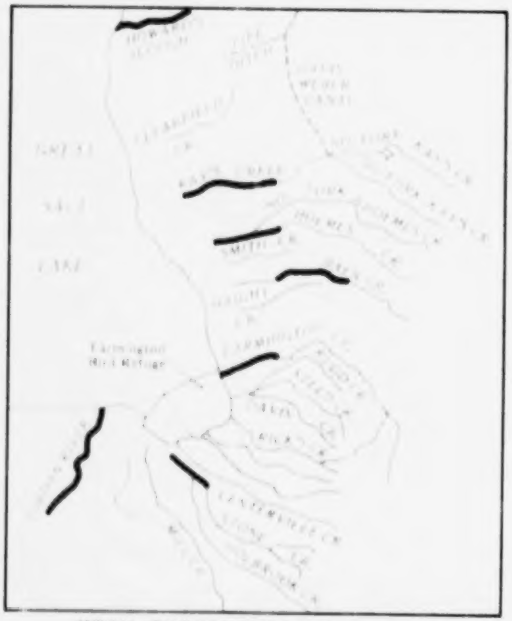
FIGURE 10-1
DAVIS COUNTY STREAMS
WATER QUALITY PROBLEMS


HOWARD'S SLOUGH
FILE DITCH
DAVIS WEBER CANAL
CLEARFIELD CR.
GREAT SALT LAKE
KAY'S CREEK
NO. FORK KAYS CR.
SO. FORK KAYS CR.
NO. FORK HOLMES CR.
HOLMES CR.
SMITH CR.
BAER CR.
HAIGHT CR.
FARMINGTON CR.
Farmington Bird Refuge
RUDD CR.
STEED CR.
DAVIS CR.
RICKS CR.
JORDAN RIVER
CENTERVILLE CR.
STONE CR.
HOLBROOK CR.
MILL CR.

PRESENCE OF OIL AND GREASE


HOWARD'S SLOUGH
FILE DITCH
DAVIS WEBER CANAL
CLEARFIELD CR.
GREAT SALT LAKE
KAY'S CREEK
NO. FORK KAYS CR.
SO. FORK KAYS CR.
NO. FORK HOLMES CR.
HOLMES CR.
SMITH CR.
BAER CR.
HAIGHT CR.
FARMINGTON CR.
Farmington Bird Refuge
RUDD CR.
STEED CR.
DAVIS CR.
RICKS CR.
JORDAN RIVER
CENTERVILLE CR.
STONE CR.
HOLBROOK CR.
MILL CR.

MEAN NITRATES > 0.5 mg/ℓ


HOWARD'S SLOUGH
FILE DITCH
DAVIS WEBER CANAL
CLEARFIELD CR.
GREAT SALT LAKE
KAY'S CREEK
NO. FORK KAYS CR.
SO. FORK KAYS CR.
NO. FORK HOLMES CR.
HOLMES CR.
SMITH CR.
BAER CR.
HAIGHT CR.
FARMINGTON CR.
Farmington Bird Refuge
RUDD CR.
STEED CR.
DAVIS CR.
RICKS CR.
JORDAN RIVER
CENTERVILLE CR.
STONE CR.
HOLBROOK CR.
MILL CR.

MEAN PHOSPHATES > 0.5 mg/ℓ

FIGURE 10-1 (Continued)
DAVIS COUNTY STREAMS
WATER QUALITY PROBLEMS

Radioactive materials have, in the past, been added to the Jordan River, principally by the now-abandoned Vitro Chemical Plant in Salt Lake County. The net effect over a period of years has been an accumulation in the southern part of the Great Salt Lake and Farmington Bay. Previous studies by Pendleton et al. in 1964 (Reference 10-3) have shown that muskrats living in Farmington Bay Bird Refuge had absorbed as high as 216 picocuries of Radium-226 per gram of body calcium, as compared to the 0.1 picocurie maximum for humans. High radioactivity can cause chromosomal aberrations resulting in mutations and freaks in aquatic organisms. Utah Fish and Game reports a relatively high incidence of abnormal muskrats taken on the Farmington Bay marshes during the trapping season. Evidence points strongly to radioactive pollutants from this source as being responsible.

Benthic sampling data on Kay's, Farmington, Stone and Mill creeks indicates moderate invertebrate populations. Species diversities of each sample collected are shown in Figure 10-2. Relatively low diversity indices, less than 1.0, were found at Kay's and Stone creeks during the summer. However, winter populations at all locations appeared to be healthy.

Salt Lake County

The changes in water quality that take place in Salt Lake County are somewhat similar to those in Davis County. Streams draining the western slope of the Wasatch Front are initially of high quality, but as the streams pass through more developed areas water quality rapidly deteriorates. Figure 10-3 shows Salt Lake County water quality parameters with mean values in excess of the limits.

The waters of the Jordan River, the main waterway in Salt Lake County, exhibit high levels of biochemical oxygen demand, coliform and total dissolved solids throughout most of the river's length.

An intensive chemical and biological survey of the Jordan River was conducted by the Environmental Protection Agency in August 1972 (Reference 10-4). The following four paragraphs are quoted from the survey report summary.

> "...The results of the microbiological study of the Jordan River indicated that the mean total coliform densities in the headwaters of the river [as it leaves Utah Lake are] less than

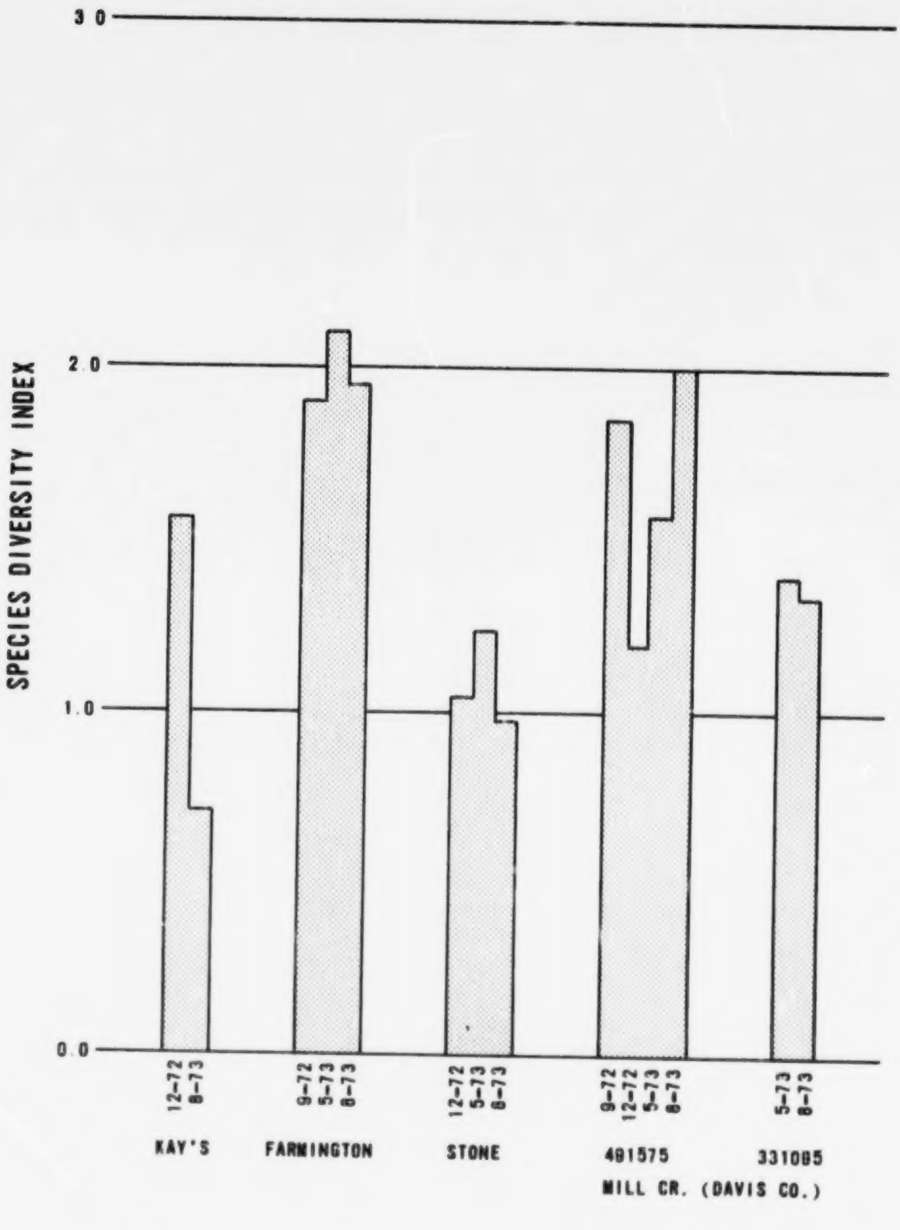
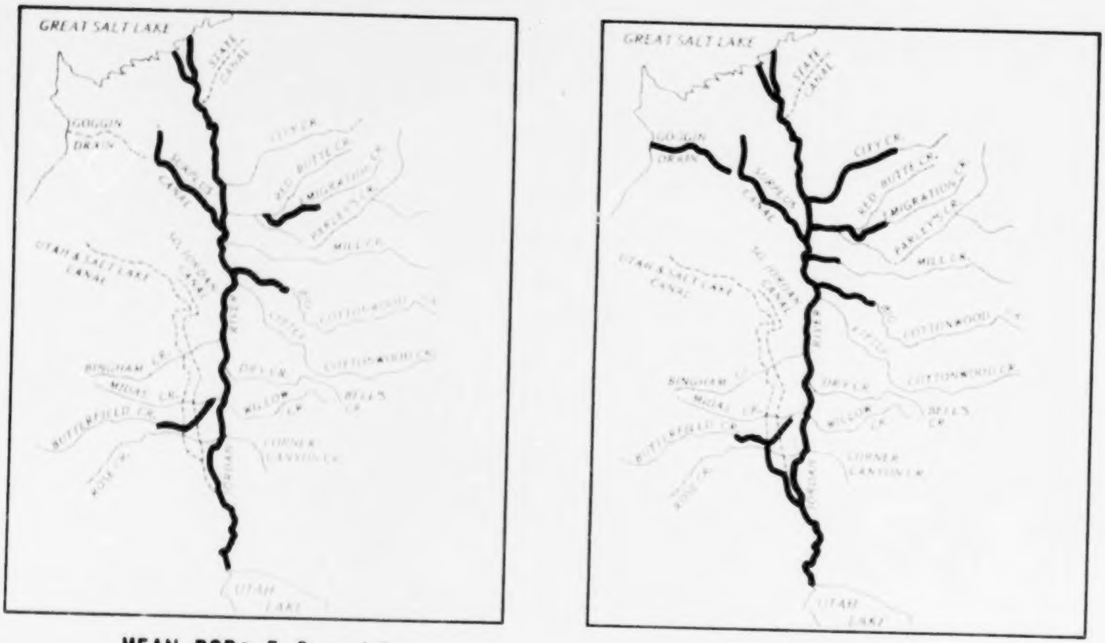
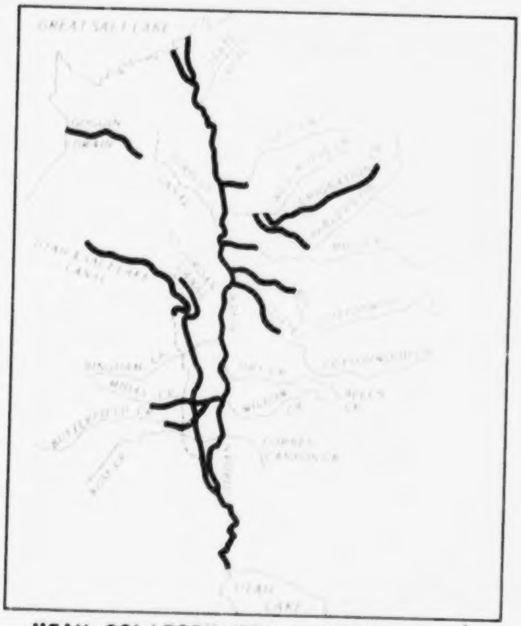


FIGURE 10-2, DAVIS COUNTY STREAMS
BENTHIC DIVERSITY


GREAT SALT LAKE
STATE CANAL
GOGGIN DRAIN
SURPLUS CANAL
CITY CR.
RED BUTTE CR.
EMIGRATION CR.
PARLEY'S CR.
MILL CR.
UTAH & SALT LAKE CANAL
SO. JORDAN CANAL
JORDAN RIVER
BIG COTTONWOOD CR.
LITTLE COTTONWOOD CR.
DRY CR.
BINGHAM CR.
MIDAS CR.
BUTTERFIELD CR.
WILLOW CR.
BELLS CR.
ROSE CR.
CORNER CANYON CR.
UTAH LAKE

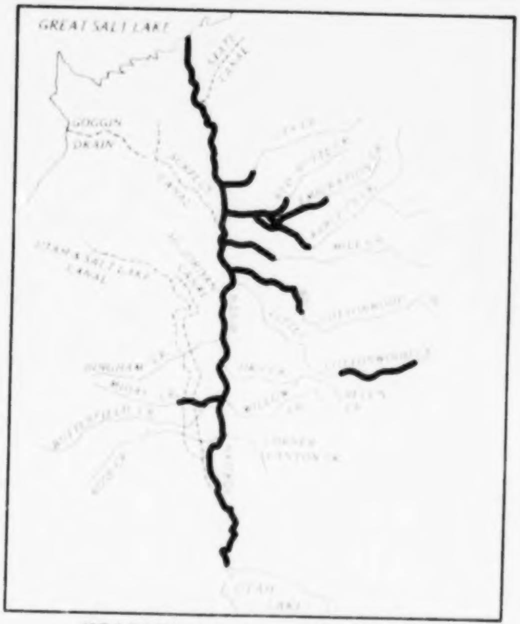
MEAN BOD> 5.0 mg/ℓ

MEAN TDS >500 mg/ℓ

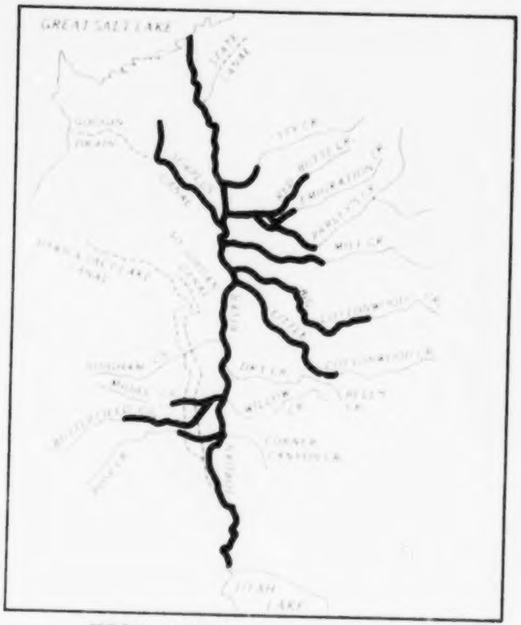

GREAT SALT LAKE
STATE CANAL
GOGGIN DRAIN
CANAL
EMIGRATION CR.
MILL CR.
UTAH & SALT LAKE CANAL
COTTONWOOD CR.
BINGHAM CR.
MIDAS CR.
DRY CR.
BUTTERFIELD CR.
WILLOW CR.
BELLS CR.
ROSE CR.
CORNER CANYON CR.
UTAH LAKE

MEAN COLIFORM MPN 5,000/100 mℓ

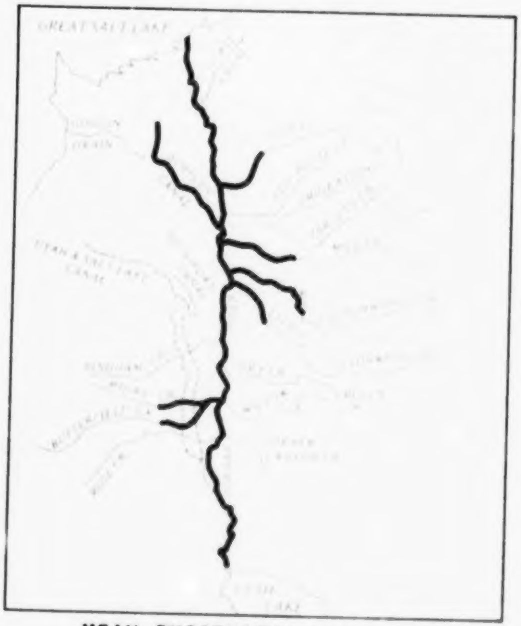
FIGURE 10-3
SALT LAKE COUNTY STREAMS
WATER QUALITY PROBLEMS


GREAT SALT LAKE
GOGGIN DRAIN
UTAH & SALT LAKE CANAL
BINGHAM CK
MILL CK
CORNER CANYON CK
UTAH LAKE

MEASURABLE OIL AND GREASE


GREAT SALT LAKE
GOGGIN DRAIN
UTAH & SALT LAKE CANAL
BINGHAM CK
MILL CK
CORNER CANYON CK
UTAH LAKE

MEAN NITRATE > 0.5 mg/ℓ


GREAT SALT LAKE
GOGGIN DRAIN
UTAH & SALT LAKE CANAL
BINGHAM CK
UTAH LAKE

MEAN PHOSPHATE > 0.5 mg/ℓ

FIGURE 10-3 (Continued)
SALT LAKE COUNTY STREAMS
WATER QUALITY PROBLEMS

> the 5,000/100 ml criteria for waters in the Basin...a condition that existed for only 13 river miles downstream. Wastes from various sources entering the Jordan River along the reach from 7800 South St....downstream through the remainder of the river caused the total coliform densities in the river to exceed the 5,000/100 ml criteria on the basis of the daily grab samples. From 3300 South St....downstream to the mouth of the Jordan River, the mean densities at each station in this reach exceeded the coliform limit.
>
> "Average dissolved oxygen values in the Jordan River were greater than the cold water fishery criteria (6.0 mg/l) from Utah Lake downstream to and including the station at 3300 South St....from 2100 South St....downstream to the mouth of the river the average D.O. values decreased and were less than the 6.0 mg/l criteria. At Cudahy Lane..., the average D.O. was 3.7 mg/l.
>
> "Significant photosynthetic activity is taking place in the Jordan River in about the upstream third of the river. Single D.O. values as high as 19 mg/l have been measured. The results of a round-the-clock study at a station in this reach....indicated that the dissolved oxygen concentrations varied from 7 to 12 mg/l over a 24-hour period.
>
> "Total phosphorus and nitrogen concentrations in the Jordan River were excessive. This is particularly significant in the area of the proposed impoundment of the river where both the phosphorus and nitrogen levels exceeded those considered as limits for waters entering impounded areas. It is probable that by impounding these waters large algal blooms, extensive growths of aquatic plants, and fish mortalities would occur. With the exception of the extreme upstream stations on Mill Creek, Big Cottonwood Creek, and Little Cottonwood Creek, the nutrient concentrations at all remaining stations on these tributaries to the Jordan River were excessive".

Profiles of dissolved oxygen and coliform content of Jordan River waters obtained during the E.P.A survey are shown in Figures 10-4 and 10-5.

Water quality sampling conducted by the basin study contractors generally supported the results of this intensive survey, although considerable water quality improvement was noted during the spring runoff when flows were high and agricultural diversions at a minimum.

Measurable oil and grease was noted throughout the length of the Jordan River and in the lower reaches of many of its tributaries, as a result of discharge of urban runoff to these waterways. Coliform counts in the lower reaches of most of the tributaries the entire length of Emigration Creek are in excess of 5,000 MPN/100 ml.

Figure 10-4

JORDAN RIVER AVERAGE DISSOLVED OXYGEN vs. RIVER MILES

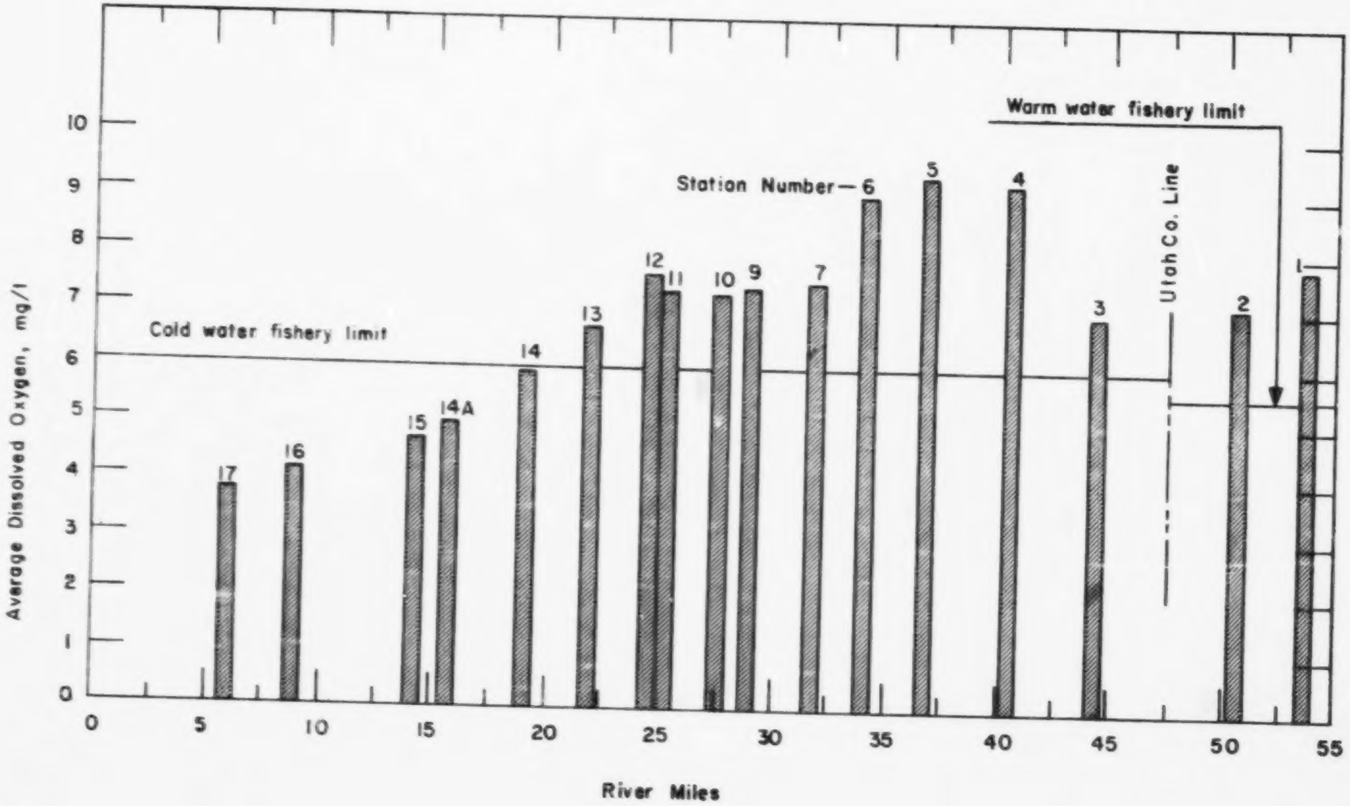
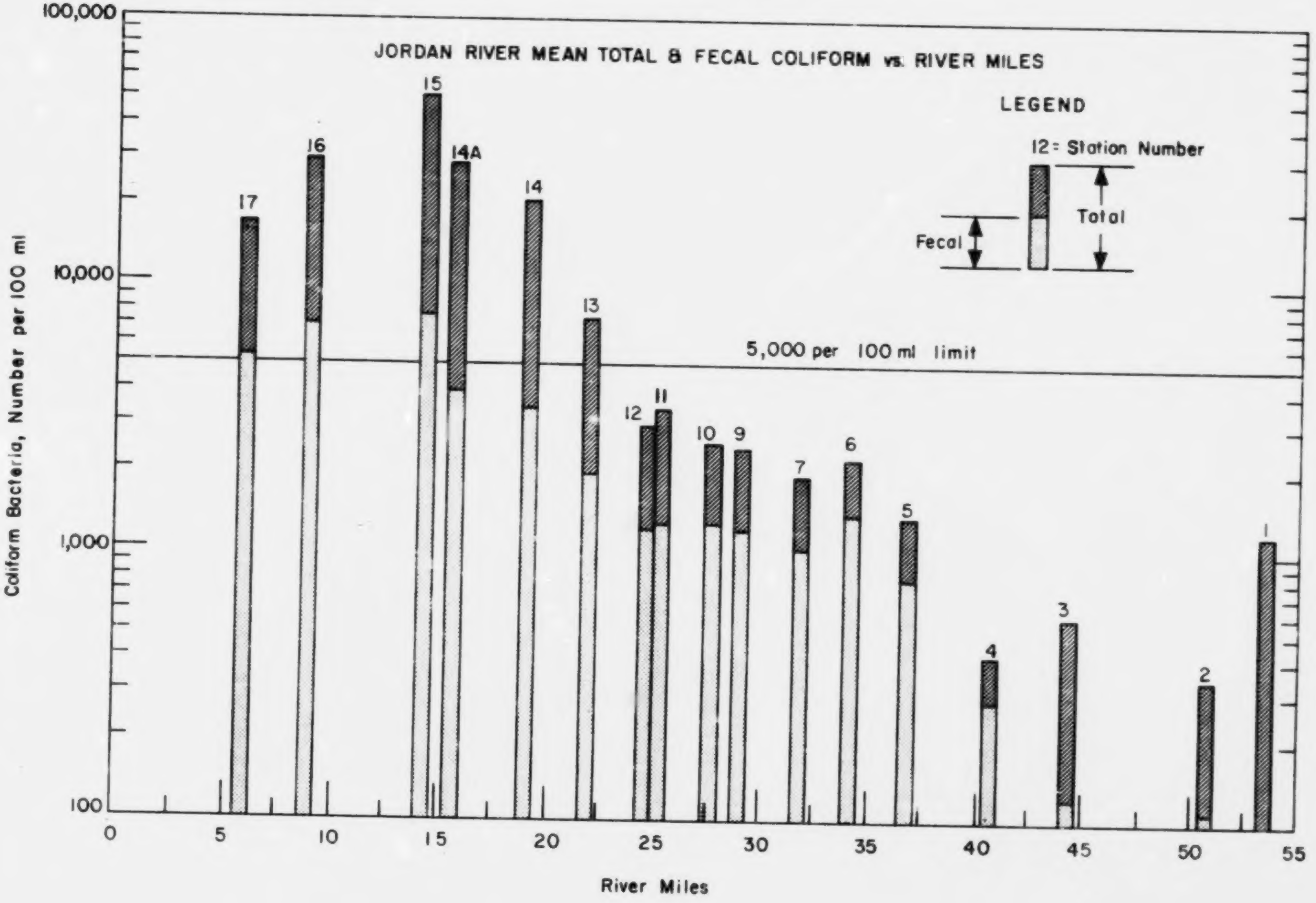


FIGURE 10-5


JORDAN RIVER MEAN TOTAL & FECAL COLIFORM vs. RIVER MILES
LEGEND
12 = Station Number
Fecal
Total
5,000 per 100 ml limit
Coliform Bacteria, Number per 100 ml
100,000
10,000
1,000
100
River Miles
0
5
10
15
20
25
30
35
40
45
50
55
17
16
15
14A
14
13
12
11
10
9
7
6
5
4
3
2
1

High levels of nitrates were found in all of the major tributaries to the Jordan River. The highest concentrations were 11.5 mg/l in the lower segment of Parley's Creek and 29.8 mg/l in Midas Creek. Phosphate levels were less extensive but peaked at 1.33 mg/l in lower Big Cottonwood Creek and 0.69 mg/l in lower Butterfield Creek.

All canals diverting water from the Jordan River frequently do not meet Class "C" standards for biochemical oxygen demand, coliform and total dissolved solids content. The high solids load is also evidenced by the high turbidity values exhibited (generally greater than 50 JTU). The BOD and coliform values are high near the point of diversion and generally show increased concentrations as the canals flow northward.

There are two areas in Salt Lake County affected by radioactive wastes: near the Stauffer Chemical plant and near the former Vitro plant on 3300 South. Discharges from the Stauffer plant into the C-7 ditch have been measured at as high as 482 picocuries/liter; however, the bulk of the radioactive wastes is retained in the evaporation ponds. Pond overflows have shown values as high as 6,948 picocuries/liter. The Vitro Chemical plant, although presently inoperative, probably continues to release radioactive leachate from the remaining tailings pile. A maximum level of 44 picocuries/liter has been recorded in the Vitro ditch above the confluence with the river.

Benthic diversity indices of selected Jordan River tributary streams are shown in Figure 10-6. Comparatively low diversity in the late summer and highest diversity in the spring indicate a definite seasonal trend.

There is a large variety of taxa found in the upper reaches and at Forest Service boundary stations on Big Cottonwood, Little Cottonwood and Mill creeks. The lower stations on each of these creeks are located near the creek's confluence with the Jordan River and in each case reflect the reduced diversity of the stream due to lowered water quality and seasonal stream diversion. The majority of organisms found at these stations are pollution-tolerant forms such as leeches and sludge worms.

Mill Creek in Salt Lake County is currently under investigation by Paul Adamus of the University of Utah for species diversity and population of drift and benthic samples (Reference 10-5). Early findings on

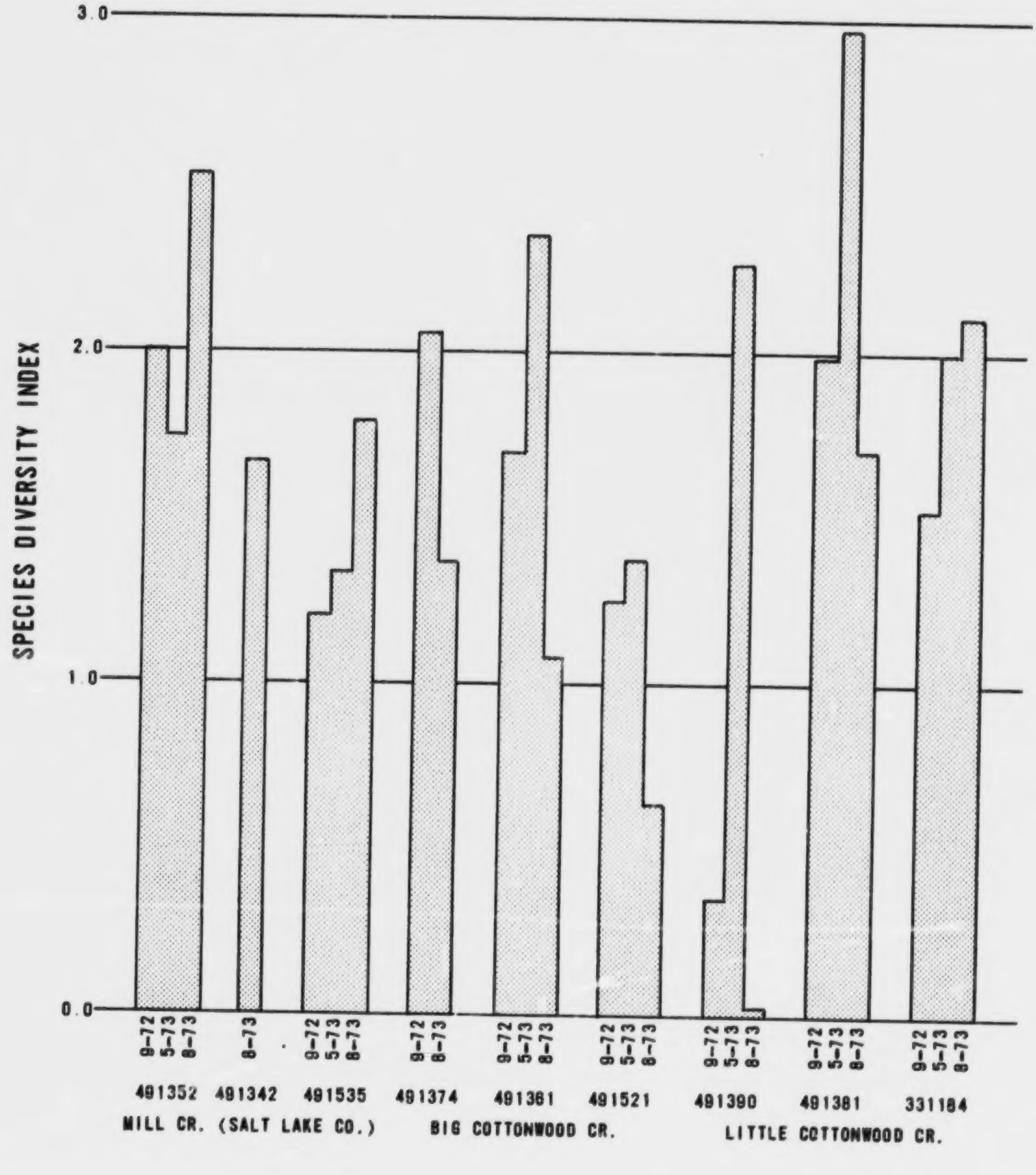


FIGURE 10-6, SALT LAKE COUNTY STREAMS
BENTHIC DIVERSITY

24-hour drift net samplings indicate a slight increase in diversity at the canyon mouth from 1972 to 1973. The 24-hour drift samples tended to have a slightly lower diversity (Margalef D.I. = 1.99) than the instantaneous benthic sample (M.D.I. = 2.69). This was attributed to the strong drifting tendencies of the mayfly *Baetis bicaudatus* at dusk. At Highland Drive and 3700 South, Mill Creek benthic diversity was 2.27 and a selected 2-1/2-hour winter-morning drift was comparable at 2.28. Although the index was lower than farther up the canyon, it still indicates a "clean" environment. Qualitative investigations of Mill Creek at 700 East and 3300 South near the Jordan River confluence indicate very poor species diversity with a disproportionate amount of fly larvae and sludge worms (*Tubifex*).

There have been three major studies completed on the biota of the Jordan River. The first was conducted by Dr. A. R. Gaufin of the University of Utah during the period 1954 to 1957 (Reference 10-6). The second study was done by R. N. Hinshaw in 1965 (Reference 10-7). The most recent work was the previously mentioned survey completed in 1972 by the Surveillance and Analysis Division of EPA (Reference 10-4). Table 10 -2 shows a qualitative comparison of benthic species found in the three studies. Figure 10 - 3 is a comparison of diversity indices at locations along the river and indicates an overall lower diversity than that of the tributary streams shown in Figure 10-7.

There are two main factors accounting for the reduced diversity of macroinvertebrates in the Jordan River. As these are benthic forms, the quality of the substrate is extremely important in determining distributional patterns. The most productive substrate is one of mixed pebbles and larger rocks. Due to silt from irrigation return flows, most of the productive types of substrate have been eliminated, and parts of the river bed are blanketed with sludge from wastewater treatment plants.

The diversity of benthic organisms is greatly reduced in the Jordan River between Utah Lake and the Jordan Narrows due to the shifting substrate of silt and sand. This observation was made in each of the three investigations. The reduced diversity below the Narrows diversion dam as noted in the EPA study may be due to the difficulty in sampling experienced at this location.

TABLE 10-2

JORDAN RIVER
QUALITATIVE ANALYSIS OF BENTHIC ORGANISMS

X = presence of organism

	Lehi- Fairfield		Narrows		14600 So.		10600 So.		9000 So.			7800 So.			6400 So.			4800 So.			3300 So.		2100 So.			1800 So.		Cudahy Lane	
	1956*	1972**	1956	1972	1956	1972	1956	1972	1956	1965**	1972	1956	1965	1972	1956	1965	1972	1956	1965	1972	1956	1972	1956	1965	1972	1956	1972	1956	1972
PLECOPTERA (stoneflies)																													
Alloperla sp.			X																										
EMPEMEROPTERA (mayflies)																													
Callibaetis sp.	X	X	X		X				X			X		X						X		X	X						
Baetis sp.			X		X	X													X										X
Tricorythodes sp.			X	X	X	X	X	X	X		X			X	X	X	X	X	X		X		X						
Stenonema sp.				X																			X						
Heptagenia sp.														X			X						X						
Ephemerella sp.			X																										
Ephoron sp.	X		X																										
Epeorus sp.																			X										
TRICHOPTERA (caddis flies)																													
Hydropsyche sp.		X	X	X	X	X	X	X	X	X	X	X		X		X	X		X	X			X						
Helicopsyche sp.					X	X																							
Hydroptila sp.								X		X	X					X													
Brachycentrus sp.					X																								
HEMIPTERA																													
Corixidae (water boatmen)	X	X			X		X	X	X	X	X	X		X	X			X		X		X	X		X	X			X
Ambrysus (creeping water bugs)					X	X												X											
Gerris sp. (water striders)					X		X		X	X		X						X					X						
Notonectidae (backswimmers)																										X			
COLEOPTERA (beetles)																													
Gyrinidae		X			X		X		X			X			X			X					X						
Elmidae			X		X	X				X	X							X	X	X									
Dytiscidae							X		X			X			X													X	
Haliplidae																										X			
Hydrophilidae												X															X		
ODONATA																													
Zygoptera (damsel flies)																													
Ceonagrionidae		X			X	X	X	X				X		X	X	X	X	X		X	X		X		X	X	X	X	X
Agrionidae					X		X		X	X	X	X														X			
Anisoptera (dragon flies)																													
Gomphidae		X	X				X		X			X			X		X	X											
DIPTERA																													
Chironomidae (midges)	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X		X		
Simulidae (black flies)			X		X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X							
Tabanidae (horse flies)														X															
Empididae (snipe flies)																	X												
Tipulidae (crane flies)					X					X						X													
Ephydridae (brine flies)			X																										
Psycodidae																X			X				X	X					
Amphipoda (scuds)																													
Hyalella azteca	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X			X		X	
Gammarus sp.		X			X		X		X		X	X	X	X	X	X		X	X		X							X	
MOLLUSCA (snails)																													
Ctenobranchiata								X																					
Physa sp.	X		X		X		X		X	X	X	X	X	X	X			X					X		X	X			X
Lymnaea sp.																													
ANNELIDA																													
Oligochaeta (sludge worms)							X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
Hirudinea (leeches)			X		X	X	X	X	X	X	X	X	X	X	X	X	X		X			X			X	X	X		X
MISCELLANEOUS																													
Asellus sp. (aquatic sowbugs)																									X				
Planaria																													X

* Study completed by Dr. Arden R. Gaufin, University of Utah, 1956-1958, reported in Hinshaw (1966).

** Hinshaw, R. N. 1966. The pollutional degradation of the Jordan River as shown by Aquatic Invertebrates. Utah State Fish and Game pub. #66-11.

*** Jordan River Study, Utah. June - August 1972. Technical Support Branch, Surveillance and Analysis Division, E.P.A., Region VIII.

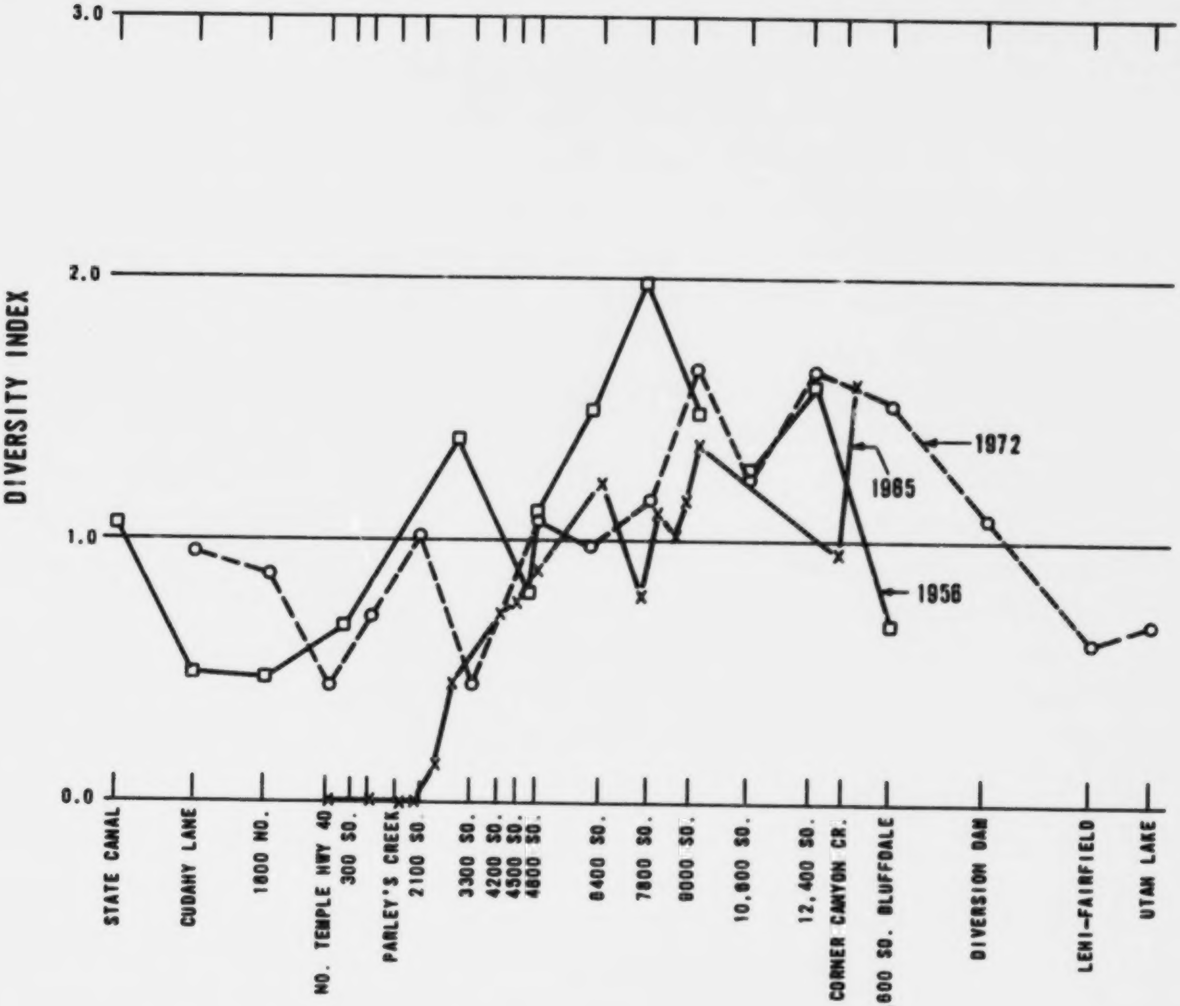


FIGURE 10-7, JORDAN RIVER
AVERAGE BENTHIC DIVERSITY

A second major factor limiting diversity is the lack of dissolved oxygen in the river due to organic wastes. As the biochemical oxygen demand loading increases, the types of organisms capable of respiration at low oxygen levels decreases. The ten wastewater treatment plants located between the Narrows and Cudahy Lane discharge an average flow of 36 MGD to the river. The organic load from the plants coupled with silt from agricultural return flows and river dredging probably account for the lack of species diversity noted in the macroinvertebrate populations within the Jordan River.

The highest diversities observed were along the river segment between Jordan Narrows and 4800 South. This part of the river is variable riffle and pool habitat with moderately clean water organisms. A drop in benthic diversity occurs near 10600 South, with a reduction in mayflies and an increase in sludge worms. There has been some dredging upstream from this station in previous years, but the principal degradation has come from the inflow of silt from agricultural operations and organic pollutants from the State Prison wastewater treatment plant. The river demonstrates a slight recovery by 9000 South, as evidenced by the increased diversity indices in each study. Between 4800 South and Parley's Creek, seven wastewater treatment plants and many storm sewers discharge into the Jordan River. The most recent EPA studies reflect clearly the drastic effects of these discharges. Species diversity and composition indicate complete exclusion of other species for the sludge worm *Tubifex tubifex*, which can tolerate the heavy silt and sludge.

Phytoplankton pigment analyses of Jordan River water samples were conducted in July 1973. A full presentation is given in Appendix B. High spectrophotometric assays of chlorophyll pigments a, b and c, along with total carotenoid pigments and the concentration of phaeopigments, indicated high concentrations of algae and plankton, with extensive zooplankton grazing on phytoplankton.

The discharge from Utah Lake, which feeds the Jordan River, contains measurable chlorophylls representing algal populations present in the lake. There appears to be a slight decrease in chlorophyll as the river flows from Utah Lake, but the river maintains a fairly constant level of chlorophyll "a" throughout its course.

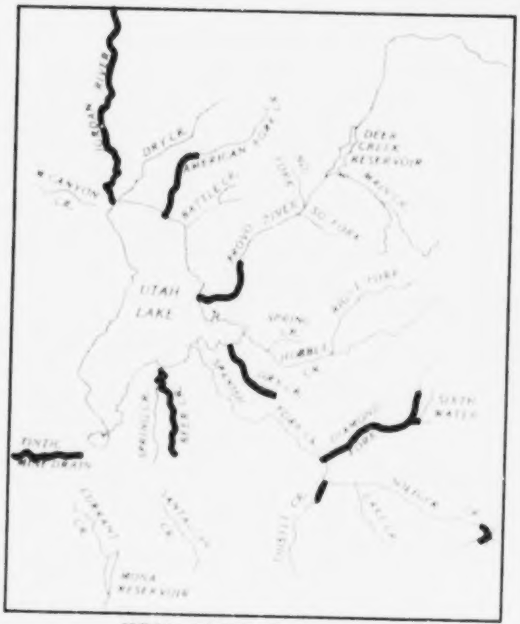
Water from the outlet of Farmington Bay and from the Surplus Canal contained the greatest amount of pigments, hence, the greatest algal concentration. Both of these sources are very slow-flowing waters with considerable turbidity. Light penetration is reduced in all of the areas sampled due to the high turbidity of the water; this is reflected in the relatively high values for phaeopigments.

Utah County

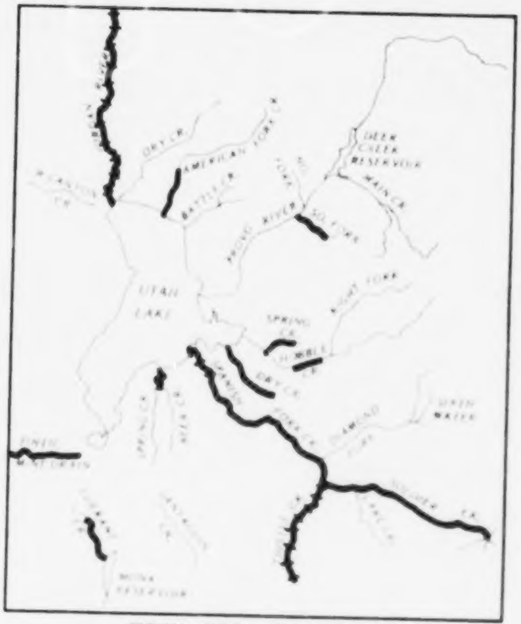
Utah County streams with near values of parameters in excess of water quality limits are shown in Figure 10-8. Sampling returns indicate many water quality problems in this county. The Diamond Fork area has shown high biochemical oxygen demand and dissolved solids values and coliform values in excess of 5,000/100 ml. Other tributaries of the Spanish Fork drainage such as Thistle Creek, Soldier Creek and Sixth Water Creek have also had BOD values in excess of Class "C" standards. Spanish Fork River near Spanish Fork has had few BOD or coliform violations but has shown traces of chromium, selenium, iron and high dissolved solids. Located near the confluence of Hobble Creek and Spring Creek are several streams which have had fairly high BOD values and high total dissolved solids values. These problems also appeared in Hobble Creek at its confluence with Spring Creek. Drainage from the Tintic Mines near Eureka has shown high concentrations of chloride, dissolved solids and iron in addition to barium, lead and arsenic. This drainage enters a holding pond, and the underground seepage probably reaches Currant Creek. The only problems on Currant Creek to date have been dissolved solids and coliform. Water quality in the lower reaches of the Provo River as it passes through the urban area exceeds the limits for BOD, coliform and oil and grease.

Nutrient enrichment is also a problem in Utah County. Extremely high levels (10.3 mg/l) of nitrate were recorded at Dry Creek near Lehi. High concentrations were also found in Spring Creek (Springville), Hobble Creek, Beer Creek and Tintic Mine Drain. High phosphate concentrations were less prevalent and peaked mainly at Dry Creek (Lehi) and Tintic Mine Drain: Nutrient addition is primarily from agricultural runoff and municipal treatment plants, noticeably on Dry Creek near the Lehi treatment plant.

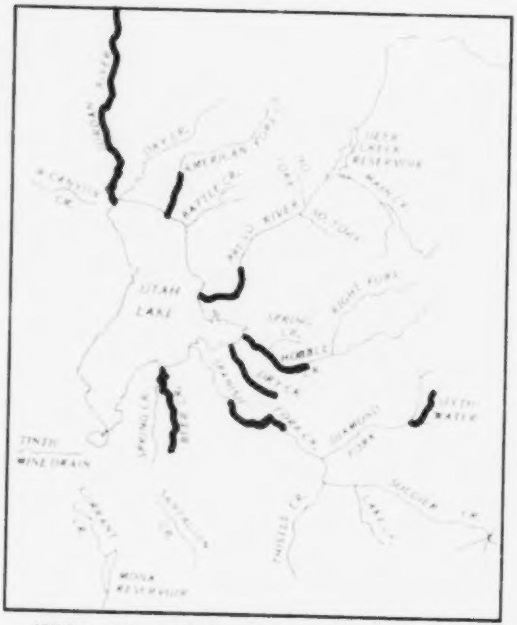
The benthic invertebrate sampling program covered the major Utah Lake tributaries of American Fork and Provo River. The Thistle Creek and Diamond


JORDAN RIVER
DRY CK.
AMERICAN FORK CK.
DEER CREEK RESERVOIR
W. CANYON CK.
BATTLE CK.
NO. FORK
PROVO RIVER
SO. FORK
MAIN CK.
UTAH LAKE
SPRING CK.
RIGHT FORK
HOBBLE CK.
SPANISH FORK CK.
DRY CK.
DIAMOND FORK
SIXTH WATER
TINTIC MINE DRAIN
SPRING CK.
CURRANT CK.
SALT CK.
THISTLE CK.
LAKE FK.
SOLDIER CK.
MONA RESERVOIR

MEAN BOD > 5.0 mg/ℓ

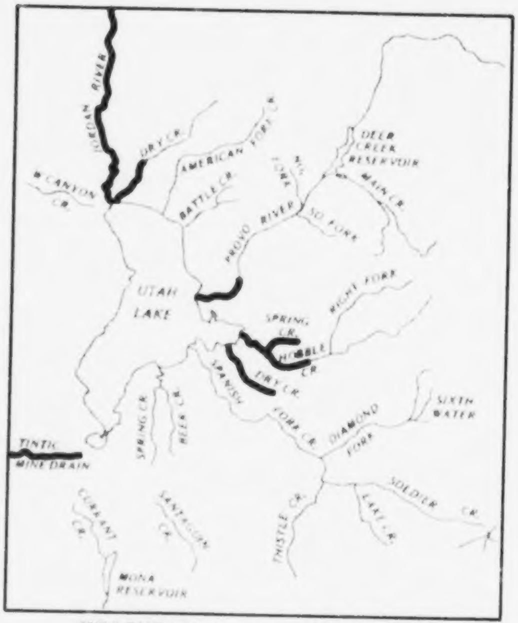

JORDAN RIVER
DRY CK.
AMERICAN FORK CK.
DEER CREEK RESERVOIR
W. CANYON CK.
BATTLE CK.
NO. FORK
PROVO RIVER
SO. FORK
MAIN CK.
UTAH LAKE
SPRING CK.
RIGHT FORK
HOBBLE CK.
SPANISH FORK CK.
DRY CK.
DIAMOND FORK
SIXTH WATER
TINTIC MINE DRAIN
SPRING CK.
CURRANT CK.
SALT CK.
THISTLE CK.
LAKE FK.
SOLDIER CK.
MONA RESERVOIR

MEAN TDS > 500 mg/ℓ
⊢+++ MEAN TDS > 1,000 mg/ℓ

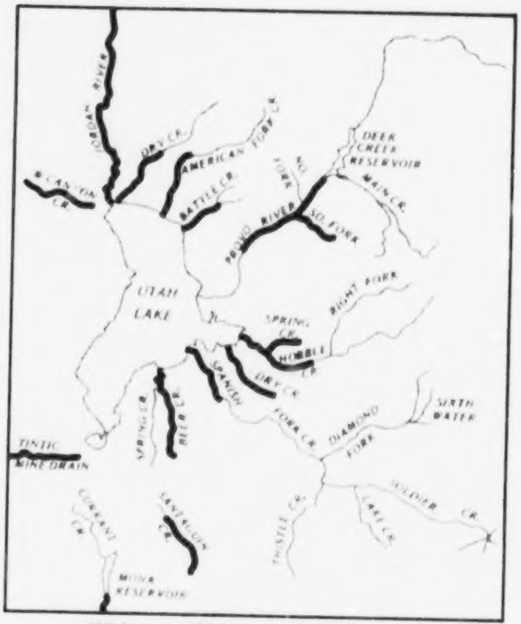

JORDAN RIVER
DRY CK.
AMERICAN FORK CK.
DEER CREEK RESERVOIR
W. CANYON CK.
BATTLE CK.
NO. FORK
PROVO RIVER
SO. FORK
MAIN CK.
UTAH LAKE
SPRING CK.
RIGHT FORK
HOBBLE CK.
SPANISH FORK CK.
DRY CK.
DIAMOND FORK
SIXTH WATER
TINTIC MINE DRAIN
SPRING CK.
CURRANT CK.
SALT CK.
THISTLE CK.
LAKE FK.
SOLDIER CK.
MONA RESERVOIR

MEAN COLIFORM MPN 5,000/100 mℓ

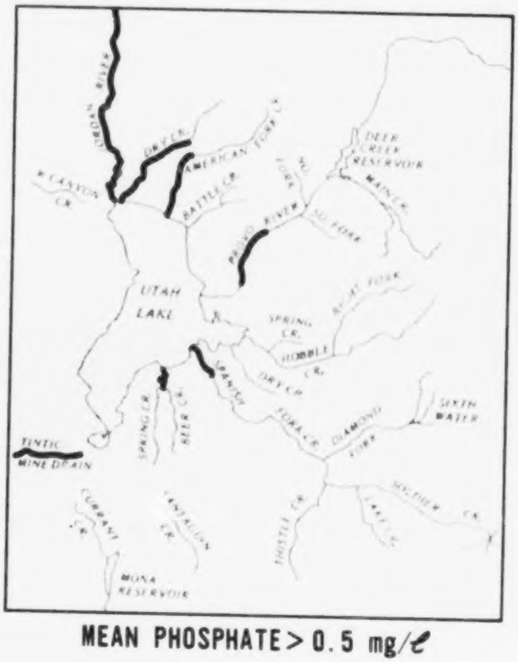
FIGURE 10-8
UTAH COUNTY STREAMS
WATER QUALITY PROBLEMS


JORDAN RIVER
W. CANYON CR.
DRY CR.
AMERICAN FORK CR.
BATTLE CR.
NO. FORK
DEER CREEK RESERVOIR
MAIN CR.
PROVO RIVER
SO. FORK
UTAH LAKE
RIGHT FORK
SPRING CR.
HOBBLE CR.
DRY CR.
SPANISH FORK CR.
DIAMOND FORK
SIXTH WATER
SPRING CR.
BEER CR.
TINTIC MINE DRAIN
CURRANT CR.
SANTAQUIN CR.
THISTLE CR.
LAKE CR.
SOLDIER CR.
MONA RESERVOIR

MEASURABLE OIL AND GREASE


JORDAN RIVER
W. CANYON CR.
DRY CR.
AMERICAN FORK CR.
BATTLE CR.
NO. FORK
DEER CREEK RESERVOIR
MAIN CR.
PROVO RIVER
SO. FORK
UTAH LAKE
RIGHT FORK
SPRING CR.
HOBBLE CR.
DRY CR.
SPANISH FORK CR.
DIAMOND FORK
SIXTH WATER
SPRING CR.
BEER CR.
TINTIC MINE DRAIN
CURRANT CR.
SANTAQUIN CR.
THISTLE CR.
LAKE CR.
SOLDIER CR.
MONA RESERVOIR

MEAN NITRATE > 0.5 mg/ℓ


JORDAN RIVER
W. CANYON CR.
DRY CR.
AMERICAN FORK CR.
BATTLE CR.
NO. FORK
DEER CREEK RESERVOIR
MAIN CR.
PROVO RIVER
SO. FORK
UTAH LAKE
RIGHT FORK
SPRING CR.
HOBBLE CR.
DRY CR.
SPANISH FORK CR.
DIAMOND FORK
SIXTH WATER
SPRING CR.
BEER CR.
TINTIC MINE DRAIN
CURRANT CR.
SANTAQUIN CR.
THISTLE CR.
LAKE CR.
SOLDIER CR.
MONA RESERVOIR

MEAN PHOSPHATE > 0.5 mg/ℓ

FIGURE 10-8 (Continued)
UTAH COUNTY STREAMS
WATER QUALITY PROBLEMS

Fork branches of the Spanish Fork River were also sampled. Sampling data as shown in Figure 10- 9 indicate moderate diversity in American Fork Creek and a relatively high diversity in the stations surveyed on the Lower Provo River. Diversity was not affected by flow through populated areas except in the late summer. Diversities on the American Fork, Provo River below Provo City and the North Fork of the Provo River near Sundance dropped severely during August, due possibly to small flows and thereby more highly concentrated pollutants. Diamond Fork and Thistle Creek showed high diversities; however, no data were available on their lower confluences or the Spanish Fork River.

Utah Lake

The waters entering Utah Lake pass through the urban areas bordering the west slope of the Wasatch Mountains. As they do so, their quality is degraded by the addition of various pollutants. Most of the water entering the lake will not meet Utah Class "C" standards for many parameters.

Prior to 1960, a few analyses had been performed on the lake waters using varying techniques and with often not directly comparable results. From 1961 to 1968, the Bureau of Reclamation performed the first extensive survey (Reference 10- 8), while the Utah Lake Research Station operated by Brigham Young University initiated extensive research in 1967 (Reference 10- 9).

The studies conducted by the Bureau of Reclamation show a regular change in all chemical parameters (except pH) as the water level of the lake changes. This is illustrated in Figures 10-10 and 10-11. During wet years, high volume rapid spring flows cause less salt per volume to enter the lake.

Results of biochemical oxygen demand and coliform analyses conducted at the Utah Lake Research Station are shown in Table 10- 3 . Despite the heavy influent pollutant loadings, Utah Lake itself is of sufficient size to dilute and degrade many pollutants down to a minimal level.

Kenison (Reference 10-10) has determined the nitrate load to Utah Lake in 1968 to be 7,638,000 pounds and the phosphate load to be 1,740,200 pounds. He calculated that 12.4 percent of the nitrate and 18 percent of the phosphate were released from the lake via the Jordan River. Wastewater

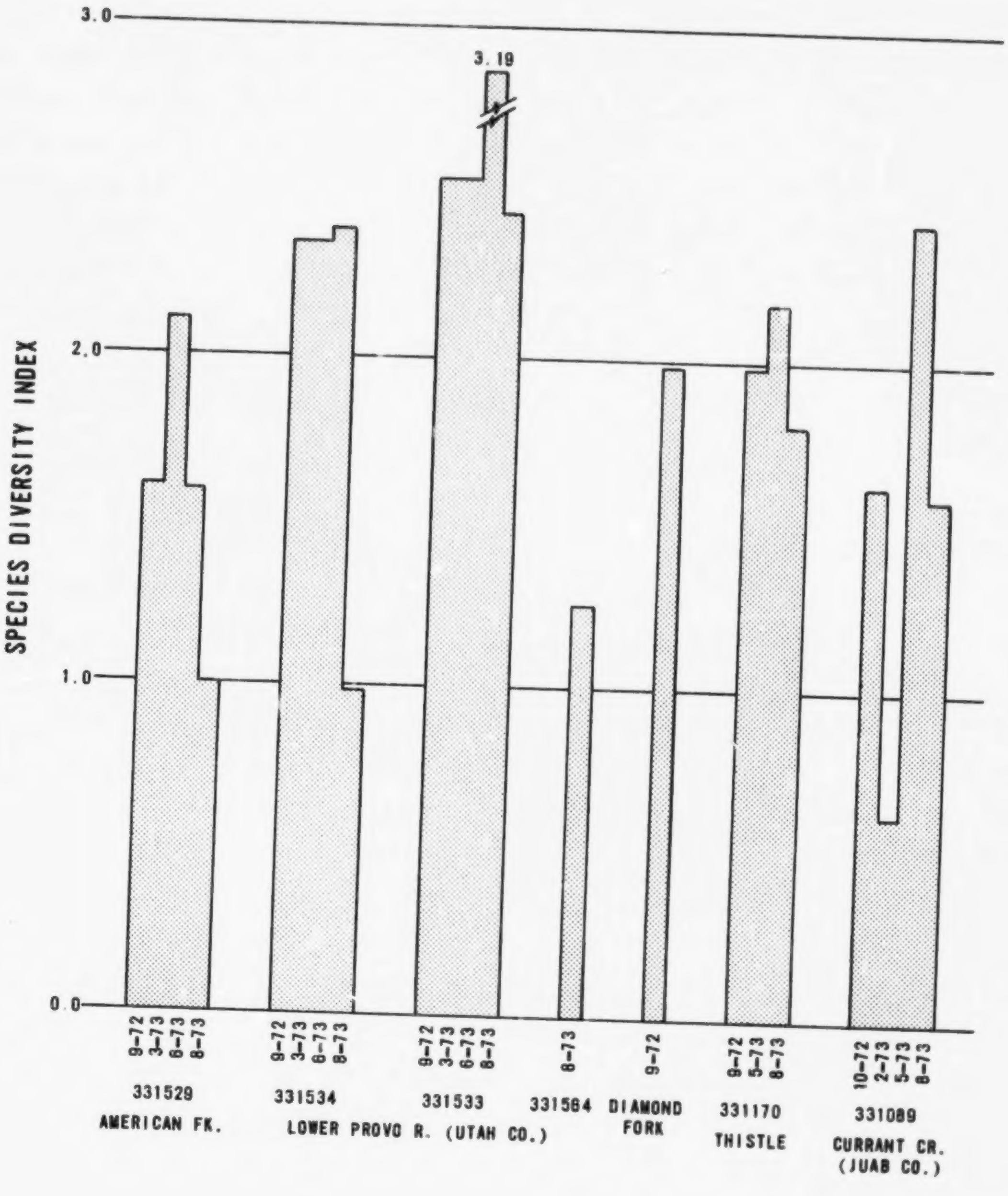


FIGURE 10-9, UTAH COUNTY STREAMS
BENTHIC DIVERSITY

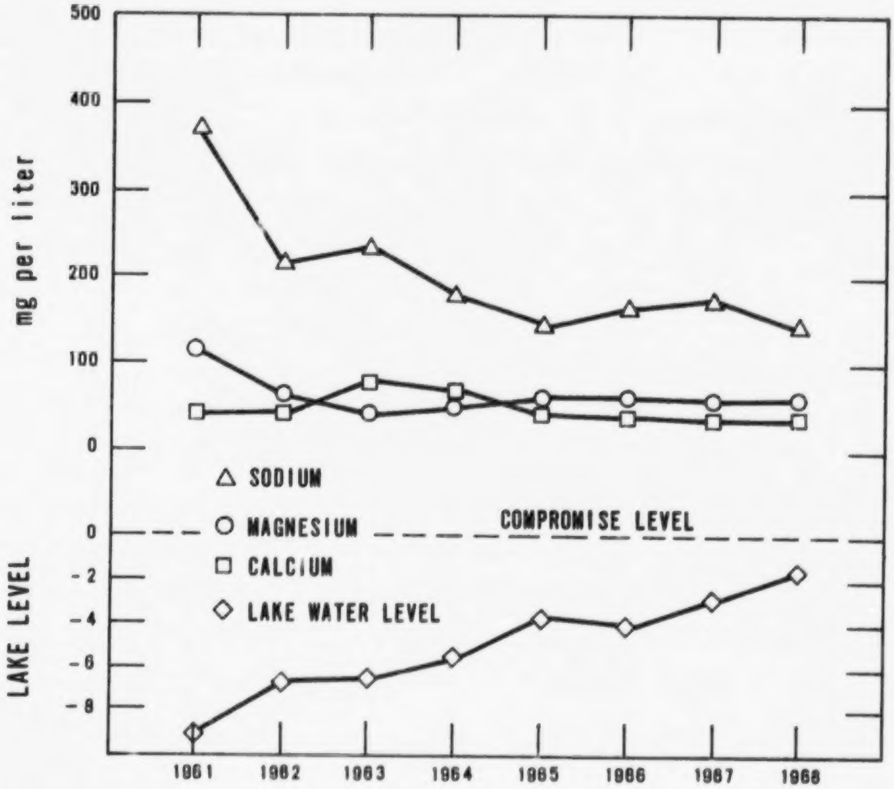


FIGURE 10-10, MEAN CONCENTRATIONS OF COMPROMISE LEVEL IN UTAH LAKE

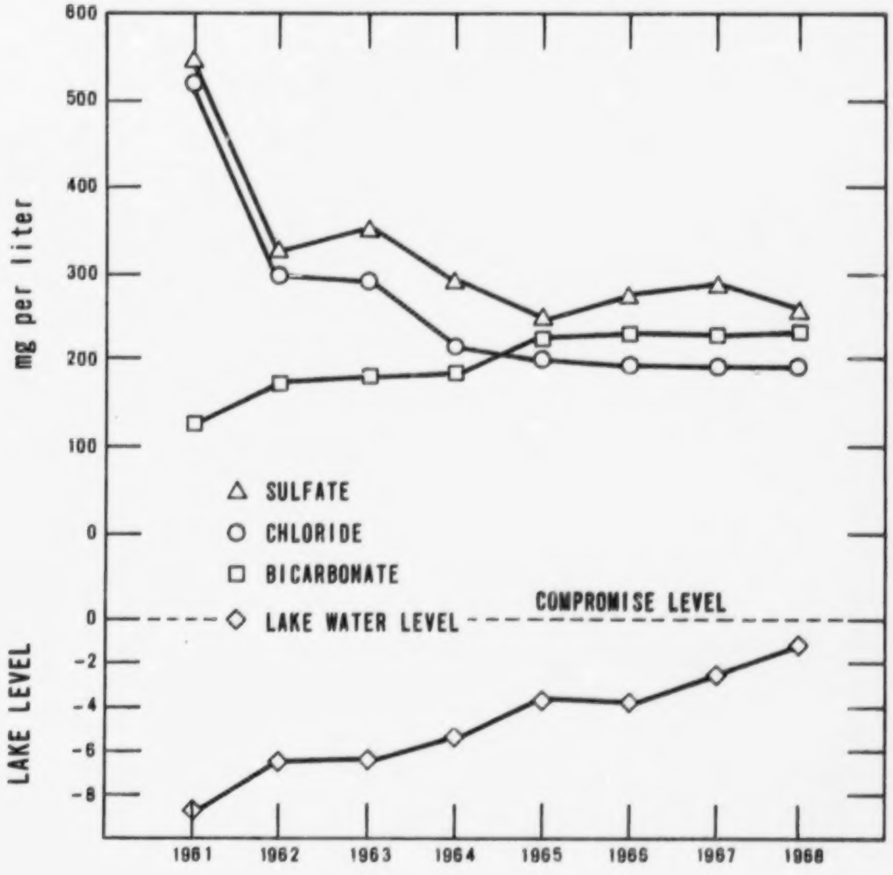


FIGURE 10-11, MEAN CONCENTRATIONS OF ANIONS IN UTAH LAKE

Table 10-3

BOD AND COLIFORM ANALYSES OF UTAH LAKE

Sample Station Location	BOD Averages 1968	BOD Averages 1969	BOD Averages 1970	MPN Averages 1968	MPN Averages 1969	MPN Averages 1970
UL 2 (300' from Provo Boat harbor)	4.9	6.6	6.8	26	1,251	46.3
UL 5 (center of lake, 2-1/4 mi. west of Orem WWTP)	4.5	2.6	1.8	111	1,725	38
UL 6 (300' from Geneva Steel)	5.7	10.4	6.9	4,735	2,517	6,439
UL 11 (center of lake, 4 mi. north of Pelican Point)	-	1.5	-	127	3,169	399
UL 19 (300' northwest of mouth of Spanish Fork River)	3.0	3.2	3.5	199	1,026	20
UL 22 (300' from Saratoga Springs Dock)	3.3	3.5	11.9	1,710	387	239
UL 24 (3 mi. northwest of Lincoln Beach)	3.4	2.7	1.4	52	325	23

treatment plants contributed 28.7 percent of the nitrate and 47.1 percent of the phosphate. Tributary inflow contributed 55.8 percent nitrate and 33.7 percent of the phosphate. Groundwater made up the remainder of the load.

Pesticide studies on the lake by the Bureau of Reclamation, commencing in 1969 (Reference 10-11), show insignificant levels (less than 0.3 parts per billion) for any given pesticide. Bangerter (Reference 10-12) believes these low pesticide levels should cause no short-range harmful effects on fish or wildlife in the lake, although long-term cumulative effects have not been fully studied. Pesticide levels appeared to follow regular cycles, with peaks during spring and summer corresponding to agricultural and other applications. (See Figures 7-4 and 7-5).

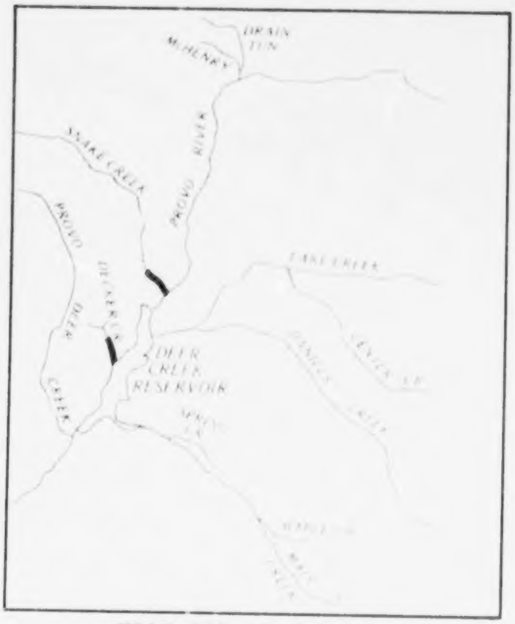
The flora and fauna of the lake have changed dramatically since the settling of the valley in the 1850's by Mormon pioneers. Work done in 1969 (Reference 10-13) comparing the biota present at that time with sparse historical records dating around 1850 indicates that there has been a general reduction in number of species and an extinction of cold, clear water species. Manipulation of water flow and degradation of water quality by man are suggested as possible reasons for the changes. The large amounts of nitrate and phosphate in the lake serve as excellent fertilizer for the algal populations, which in turn feed the carp and catfish. The reduced species diversity coupled with the large input of nutrients indicates that the lake is now very eutrophic. It appears, however, that the high turbidity generally present in the lake markedly attenuates light penetration with a resulting decrease in phytoplankton productivity.

Wasatch County

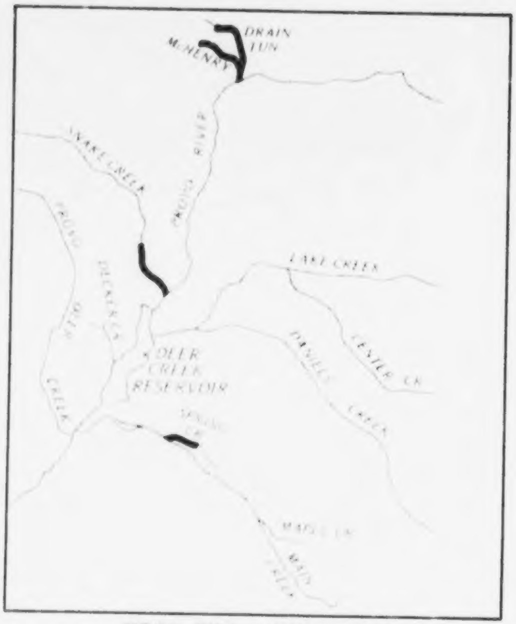
Sample returns have indicated few water quality problems in Wasatch County. Streams in excess of water quality limits are shown in Figure 10-12. In the Wallsburg area, oil contamination of both Spring Creek and Main Creek was noted. Snake Creek contributes some biochemical oxygen demand loading to the Provo River, a small portion of which comes from the Midway fish hatchery.

Coliform concentrations are low and limited to portions of Spring Creek and Decker Creek. Nutrient enrichment appears to be the predominant problem in tributaries to the Deer Creek Reservoir. Excessive nitrogen and phosphate levels are visible in Main, Daniels, Center, Lake and Snake Creeks as well as in the upper Provo River. Nutrient sources are most probably from agricultural runoff and municipal wastewater. Radiological analyses indicate two picocuries/liter at a station 50 feet above the Heber treatment plant outfall and 10 picocuries/liter at the Midway treatment plant outfall. The only other areas with potential problems are Drain Tunnel and McHenry's Canyon Creek. Total dissolved solids values for these streams are generally in excess of 500 mg/l and BOD and coliform values are in excess of Class "C" standards.

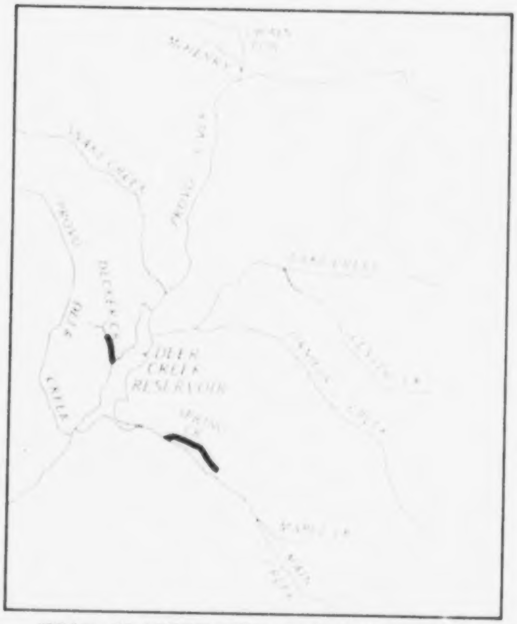
Benthic invertebrate analyses, as shown in Figure 10-13, indicate a seasonal late summer drop in diversity along the upper Provo River. The most notable drop occurs at McHenry's, where there is probably minimal summer flow and high total dissolved solids. Although Drain Tunnel Creek was not studied, similar characteristics would be expected. The remainder of the streams sampled in Wasatch County demonstrate a fair degree of diversity, characteristic of mountain streams.


DRAIN TUN
McHENRY
SNAKE CREEK
PROVO RIVER
PROVO
DECKER CR
DEER
CREEK
LAKE CREEK
CENTER CR
DANIELS CREEK
DEER CREEK RESERVOIR
SPRING CR
MAPLE CR
MAIN CREEK

MEAN BOD 5.0 mg/ℓ

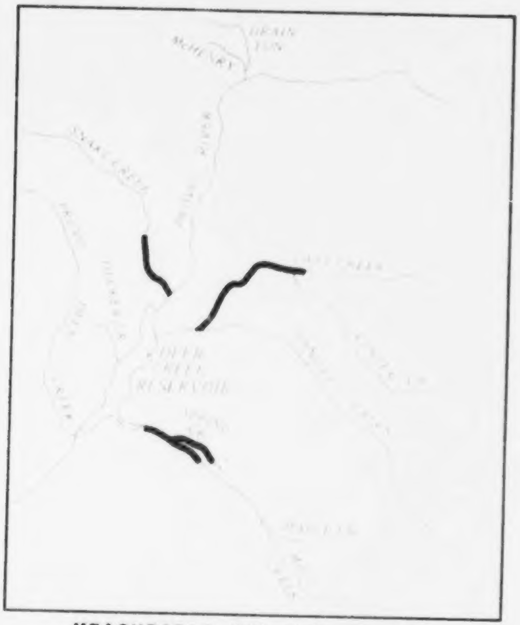

DRAIN TUN
McHENRY
SNAKE CREEK
PROVO RIVER
PROVO
DECKER CR
DEER
CREEK
LAKE CREEK
CENTER CR
DANIELS CREEK
DEER CREEK RESERVOIR
SPRING CR
MAPLE CR
MAIN CREEK

MEAN TDS 500 mg/ℓ

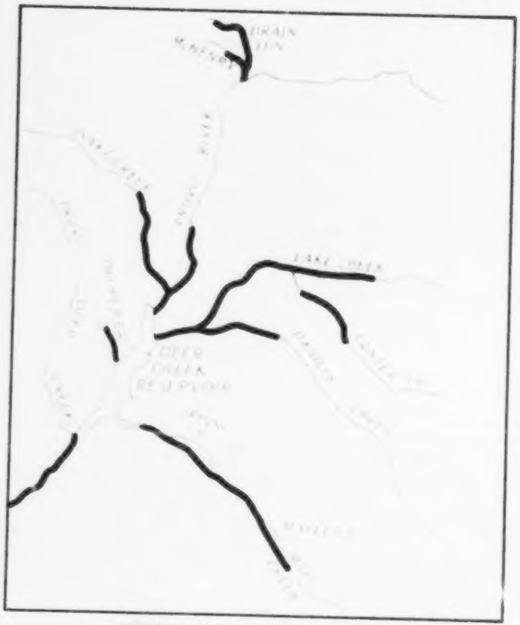

DRAIN TUN
McHENRY
SNAKE CREEK
PROVO RIVER
PROVO
DECKER CR
DEER
CREEK
LAKE CREEK
CENTER CR
DANIELS CREEK
DEER CREEK RESERVOIR
SPRING CR
MAPLE CR
MAIN CREEK

MEAN CLIFORM MPN 5,000/100 mℓ

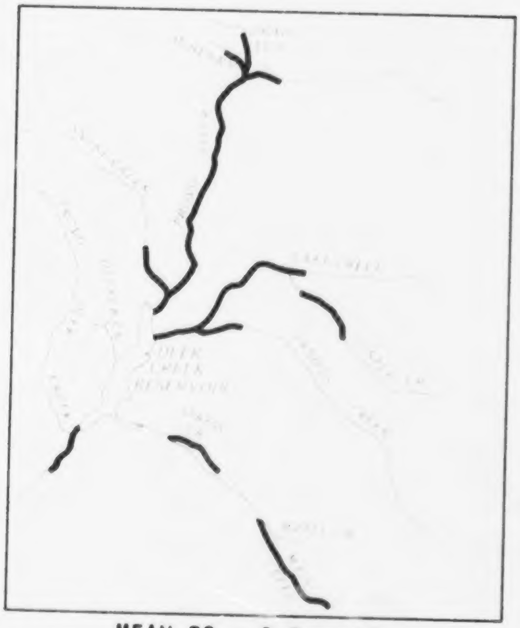
FIGURE 10-12
WASATCH COUNTY STREAMS
WATER QUALITY PROBLEMS


DRAIN TUN
McHENRY
SNAKE CREEK
PROVO RIVER
LAKE CREEK
DEER CREEK RESERVOIR

MEASURABLE OIL AND GREASE


DRAIN TUN
McHENRY
SNAKE CREEK
PROVO RIVER
LAKE CREEK
DEER CREEK RESERVOIR
CENTER CR.

MEAN $NO_3 > 0.5$ mg/ℓ


SNAKE CREEK
LAKE CREEK
DEER CREEK RESERVOIR

MEAN $PO_4 > 0.5$ mg/ℓ

FIGURE 10-12 (Continued)
WASATCH COUNTY STREAMS
WATER QUALITY PROBLEMS

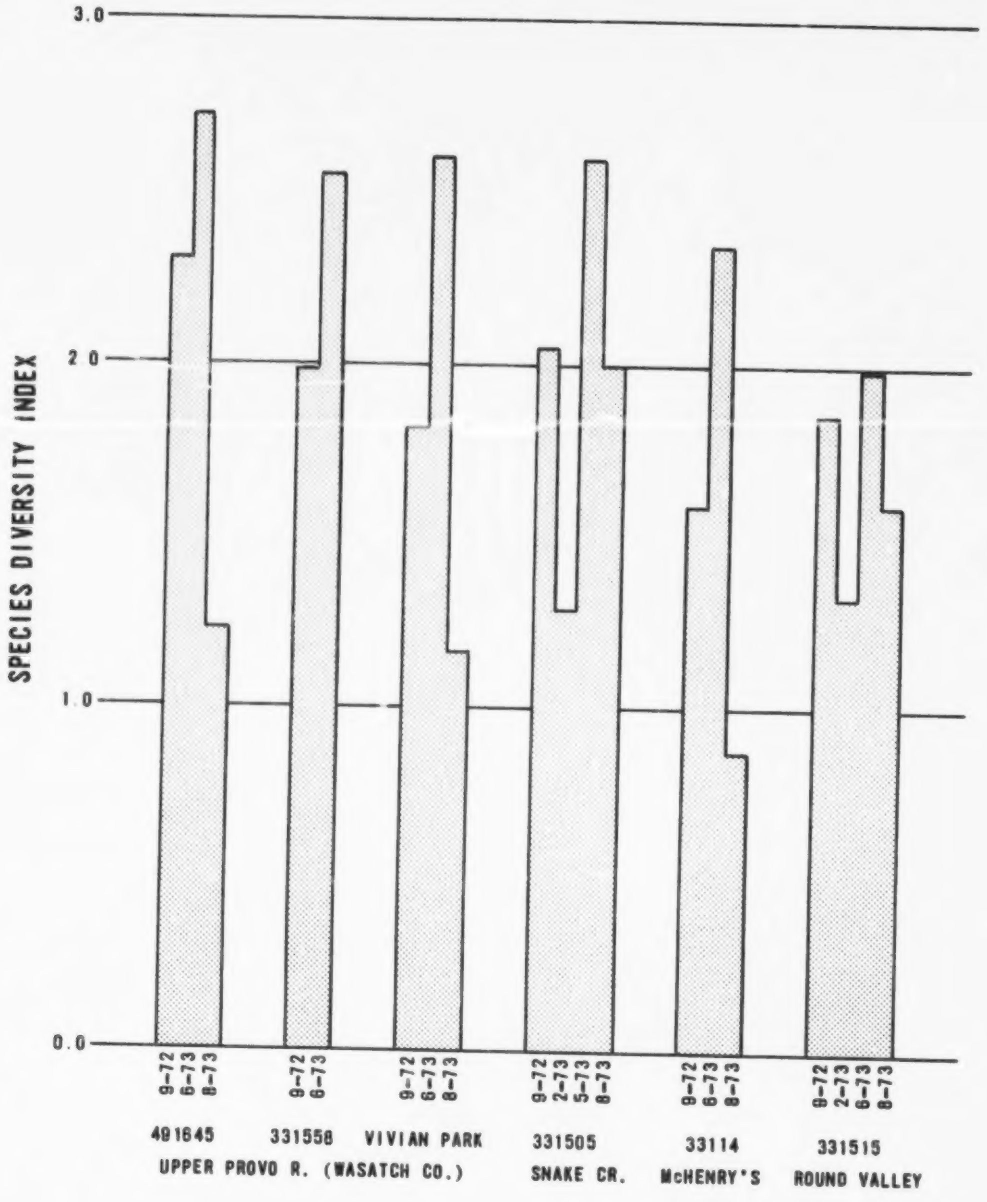


FIGURE 10-13, WASATCH AND JUAB COUNTY STREAMS
BENTHIC DIVERSITY

WATER QUALITY BY STREAM SEGMENT

The surface waters of the basin were divided into 114 stream segments as an aid to water quality analysis. Stream segments, delineated by river miles are shown in Appendix 10-A together with average and maximum or, where appropriate, minimum values of water quality parameters. The status of water quality in the major streams with respect to Utah's Class "C" standards is shown in Table 10-4.

One purpose of the characterization of existing water quality is to identify seriously polluted stream segments. This information is useful in developing priorities for remedial measures.

In general, pollution is most severe in the downstream segments of the basin's water courses. Other factors must be accounted for in the development of priorities and these are discussed more fully in Chapter 14.

TABLE 10-4

MAJOR STREAMS - WATER QUALITY REFERRED TO CLASS "C" STANDARDS

			WATER QUALITY PARAMETERS									
			pH		DO		BOD		COLIFORM		TDS	
STREAM	SEGMENT	RIVER MILE	MIN.	MAX.	AV.	MIN.	AV.	MAX.	AV.	MAX.	AV.	MAX.
Jordan River	JR1	0.0-8.8	C[a]	C	C	V[b]	V	V	V	V	V	V
	JR2	8.8-18.2	C	C	C	V	V	V	V	V	V	V
	JR3	18.2-25.0	V	C	C	V	V	V	V	V	V	V
	JR4	25.0-31.8	C	C	C	C	V	V	V	V	V	V
	JR5	31.8-44.0	C	C	C	C	C	V	V	V	V	V
	JR6	44.0-55.0	C	C	C	C	V	V	C	V	V	V
Little Cottonwood Creek	LCC1	0.0-11.0	C	C	C	C	C	V	C	V	V	V
	LCC2	11.0-22.0	C	V	C	C	C	C	C	C	C	C
Lower Provo River	PR1	0.0-6.0	C	C	C	C	C	V	C	V	C	C
	PR2	6.0-18.5	C	C	-	-	C	C	C	C	C	C
	PR3	18.5-24.5	C	C	C	V	C	C	C	C	C	C
Spanish Fork	SF1	0.0-11.5	C	C	C	V	C	V	C	C	V	V
	SF2	11.5-18.6	C	V	C	C	C	C	V	V	V	V
	SF3	18.6-21.2	-	-	C	C	C	V	C	C	C	C
Upper Provo River	PR4	24.2-32.2	-	-	C	C	C	V	C	V	C	C
	PR5	32.2-40.2	-	-	-	-	C	C	C	V	C	C
	PR6	40.2-44.2	C	C	C	C	C	C	C	C	C	C

[a] C - In Compliance with Class "C" Standards

[b] V - In Violation of Class "C" Standards

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CHAPTER 11

WASTE DISPOSAL AND WATER QUALITY

INTRODUCTION

The preceding chapters have discussed in detail the existing situation: the physical and human environment, present water quality and the sources and magnitudes of the waste loads imposed on the streams. In Chapter 8 water quality goals and regulatory strategies to acheive them were described. The purpose of this chapter is to outline the methods presently available to reduce waste loads and to evaluate the resulting effect on receiving water quality.

Water quality may be altered in a multitude of ways. Historically most of the alterations resulting from man's activities have led to degradation of water quality and limitation of water use. Efforts have been made during the last century to slow or halt the rate of water quality degradation by the introduction of engineered wastewater collection, treatment and disposal systems. While these measures have, in fact, ameliorated water pollution, water quality in many of the streams in the study area remains below that level which will support a wide range of beneficial uses.

Clean water can be restored in two ways: by reducing human population and activity within the basin to a level that can be supported by hunting and gathering the natural resources of the basin or by regulating man's activities to minimize the negative impact on water quality. Rejecting the former course, despite the enthusiasms of a growing number of latter day Thoreaus, it is apparent that four principal options exist for regulation of man's activities to minimize water pollution: source control of wastes, wastewater treatment, relocation of disposal sites and instream quality/quantity modification.

SOURCE CONTROL MEASURES

Source control measures are actions that alter or eliminate a waste at or near its source. Examples of source control measures are industrial process changes that reduce the volume and strength of waste streams, good street-cleaning practices that reduce the pollutional potential of urban runoff, and design and management of livestock corrals to minimize generation of polluted runoff.

Control of Waste Generation by Land-Use Regulation

As the science of pollution control has developed it has become increasingly clear that water pollution cannot be considered in isolation; the interrelationships between air and water quality and land use make it vital that an integrated approach to environmental protection be adopted. Enforcement of air pollution laws, for example, will reduce the amounts of certain materials deposited on the land surface and available for flushing into the surface or groundwaters. Ultimately it will be necessary to conduct comprehensive environmental planning studies that encompass all aspects of the human environment. In the interim, however, it may be necessary to adopt land use controls as a tool for protection of high quality waters when other more conventional methods are ineffective.

Within the study area, the canyons of the Wasatch Front, serving as a catchment for Salt Lake City's water supply, provide an example of an area where further land use regulation may be necessary if water quality is to be protected (Reference 11-1). Bacteriological contamination of the mountain streams appears to be correlated with the number of persons visiting the canyons. If water quality continues to deteriorate it may be necessary to restrict the number of canyon visitors.

Urban Housekeeping

As discussed in Chapter 7, a potent source of pollution-causing material is the accumulated debris of urban living that is flushed into the surface streams during storms. In Salt Lake County it is estimated that polluted urban runoff contributes an average of 6,838 lbs/day of biochemical oxygen demand to the surface streams or approximately 15 percent of the biochemical oxygen demand attributable to discharges of treated municipal wastewater. Maximum BOD loads will vary dependent upon storm frequency, storm intensity, etc.

Although it is inevitable that stormwaters passing through the urban environment will pick up some pollution-causing material, a number of remedial measures, short of stormwater treatment, have been suggested

(References 11-2 and 11-3). Improved street-cleaning operations and enforcement of anti-litter laws can reduce the quantity of debris susceptible to flushing out by stormwater, as can a routine program of catchbasin and strom sewer cleaning. Herbicides and deicing chemicals should be used sparingly, and snow cleared from highways should not be dumped directly into stream channels.

A longer term approach is to introduce water pollution control measures into the planning of urban developments. Development near streams and on steep slopes is deleterious to water quality and should be avoided. Use of porous pavements to facilitate local recharge and reduce storm runoff peaks may reduce a real mass emission rates of pollutants to the surface waters.

Source Control of Industrial Wastes

There are three principal means of industrial source control: process selection to minimize the volume and strength of wastewaters, regulation of the quality and quantity of wastes discharged to the municipal sewer systems and in-plant housekeeping.

In the past the choice of a process to meet an industrial objective was made with little regard for prevention of water pollution since no financial penalties were incurred when pollution resulted. As local, State and Federal agencies charged with the responsibility for water pollution control began to require that waste discharges meet certain standards, the cost of the necessary waste treatment facilities began to figure more prominently in the selction process. A study of the petroleum refining industry (Reference 11-4), for example, indicated that waste emissions per unit of product from modern refineries are considerably less than for refineries employing older technologies, as shown in Table 11-1.

This trend is expected to accelerate as the EPA and the State implement the provisions of the Federal Water Pollution Control Act as amended in 1972 by establishing and enforcing, through the NPDES system, allowable waste emissions per unit of industrial product that represent the best practicable control technology. The proposed requirements for

Table 11-1

WASTE LOADS FROM 100,000 BPD OIL REFINERY

Type of Technology	Flow, MGD	BOD, lbs/day	Phenol, lbs/day	Sulfide, lbs/day
Older	25.0	40,000	3,000	1,000
Typical	10.0	10,000	1,000	300
Newer	5.0	5,000	500	300
EPA Proposed Best Practicable Effluent Control[a]		3,200	25	14

[a] Proposed Federal Register 20 December 1973

the petrochemical industry, well represented in the study area, are shown in Table 11-1.

The second means of industrial source control is pretreatment of industrial wastes prior to discharge into the municipal sewer system. The purpose of pretreatment is to prevent the introduction of toxic materials, such as heavy metals and pesticides, into the municipal waste stream. Many of these materials pass through the municipal treatment plant substantially unaltered and may have a deleterious effect on conventional biological waste treatment processes. Pretreatment of industrial wastes can be required by the passage of sewer ordinances that regulate the quality of wastewaters discharged to a municipal sewer system.

Many of the municipalities and sewerage agencies within the study area have enacted sewer ordinances which are, in general, simply prohibitions of discharge of materials that may be harmful to the sewer system. The EPA proposes to issue standards for pretreatment of pollutants introduced into publicly owned treatment works that will regulate the discharge to the sewer of both materials that may harm the wastewater facilities and materials that pass through the treatment plant substantially unaffected. The most significant provision of the proposed standards, published in 1973, (Reference 11-5) is that the allowable mass emission rates from industrial sources shall be those that result from the application of best practicable control technology to the industrial source. Definitions of best practicable technology for various industries are currently being formulated by EPA. Some of the requirements pertinent to the study area are shown in Table 11-1.

The full implications of the new pretreatment regulations are as yet unclear; however, it is likely that increased efforts will have to be made to exclude from the sewer system substances that may harm the municipal biological waste treatment system. Concentrations of those substances that may have an adverse impact on biological systems are shown in Table 11-2 together with their measured concentrations in municipal wastewater effluents in the study area. Even allowing for only minor removals in the treatment process

Table 11-2

METALS THAT INHIBIT BIOLOGICAL TREATMENT PROCESS

Parameter	Concentration, μg/ℓ						
	South Davis County North Plant	Salt Lake City	Salt Lake City SSD #1	Orem City	Provo City	Heber City	Recommended Limits
Chromium (hexavalent)	20.37	39.11	0.142	0.57	0.15	1.44	2,000
Chromium (total)	-	260.00	0.000	-	-	-	5,000
Copper	192.50	17.40	9.666	12.00	13.08	12.21	1,000
Lead	2.06	10.69	3.33	2.62	1.94	9.54	100
Nickel	1.66	0.0	0.0	0.0	2.50	0.0	100
Silver	16.15	9.50	12.27	4.80	8.36	17.88	30
Zinc	26.65	17.71	29.04	29.09	33.79	37.60	5,000

the present quality of the municipal wastewater in the study area appears to pose no threat to the integrity of the biological systems.

In-plant house-keeping is an effective industrial source control measure; many industrial operations have been able to reduce waste emissions substantially by making minor changes in operation and maintenance practices. In addition, the industrial waste management problem can be simplified by designing industrial facilities that allow the segregation and separate treatment of different waste streams.

Source Control of Agricultural Wastes

The two main sources of agricultural wastes, crop irrigation and animal husbandry, are both amenable to source control; in fact, in the former case source control is virtually the only pollution control measure available. The highly dispersed occurence of irrigation wastewaters and animal wastes in the study area places responsibility for pollution control upon individual farmers and to a lesser degree on the irrigation and drainage companies.

Irrigation Wastewaters--

Waste loads resulting from crop irrigation can be greatly reduced in volume by the adoption of water-conserving irrigation practices that frequently afford the farmer other benefits in addition to that of pollution control.

Adoption of sprinker irrigation rather than the commonly employed flooding system offers many advantages, most of which derive from the fact that wastes are essentially contained within the root zone of the farm. Sprinkler systems are amenable to rather precise engineering design, taking into account crop needs, soil conditions, wind prevalence, topography and other relevant factors. Thus the system is highly efficient in water application, so that crop needs are satisfied and leaching requirements are met without excessive wastage.

Application rates with sprinkler systems are usually set lower than the percolation rate of the soils upon which water is sprinkled. Thus, as long as the systems operate properly, surface runoff and its associated pollutional characteristics are non-existent. Trends in the application of sprinkler irrigation are shown in Figure 11-1.

SOURCE: "IRRIGATION WELL," BI-MONTHLY JOURNAL PUBLISHED BY WATER WELL ENGINEERING

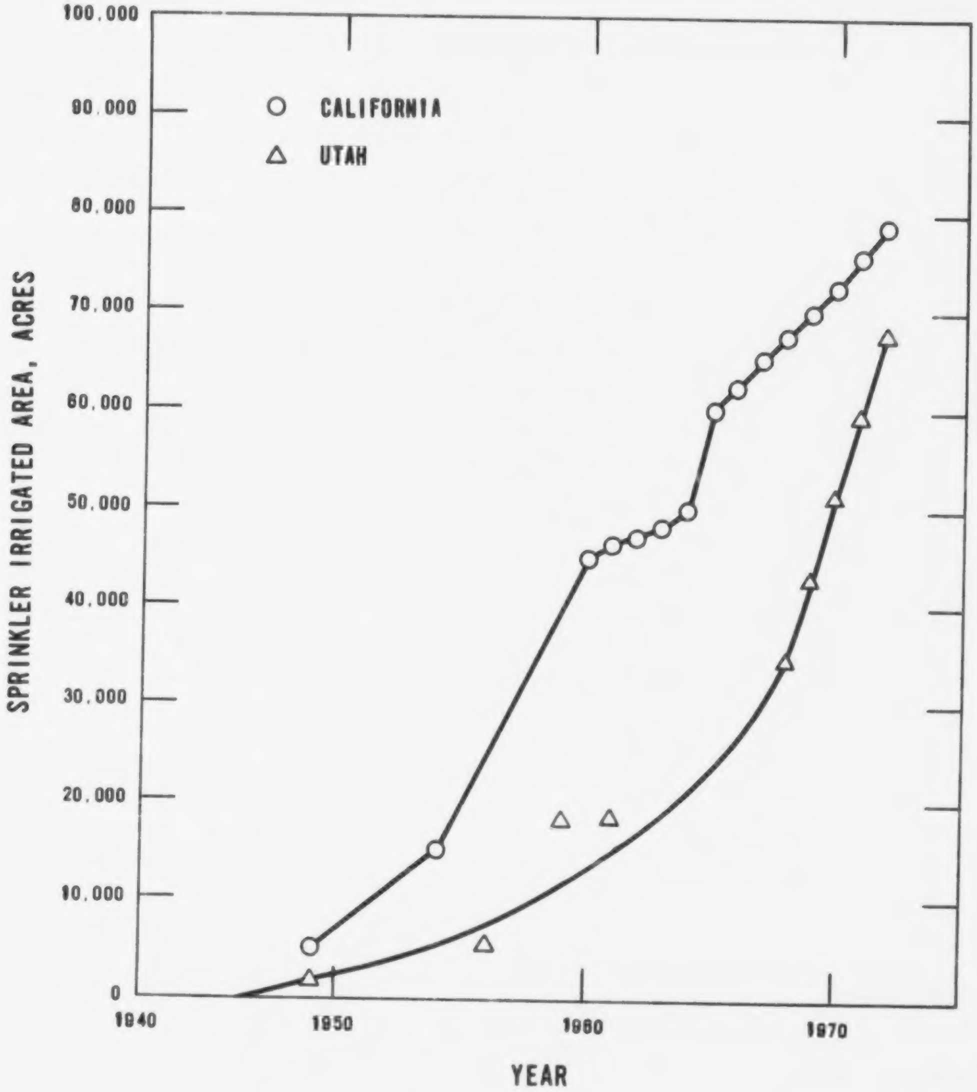


FIGURE 11-1 TRENDS IN THE APPLICATION OF SPRINKLER IRRIGATION

In many cases the use of sprinkler systems eliminates unlined conveyance ditches. Ditches commonly result in leaching of water--and pollutants, especially where tail water is partially recycled--to the groundwater reservoirs.

Other methods for reducing the volume of irrigation wastewaters include improvement of irrigation efficiencies of existing methods, recycle of surface return flow for use on other irrigated lands and lining of unlined ditches.

Almost all the irrigation systems presently in use can be made more efficient by redesign of the system, repair of dikes and ditches, land grading and maintenance, close control of irrigation duration and frequency, weed control, prevention of excess runoff and deep seepage, and other standard food farming practices. Such improvement inevitably reduces the irrigation waste loads imposed upon the natural waters of the study area.

Animal Wastes--

Lack of concentrated animal populations (feedlots, large dairies, stables, etc.) in the study area makes the animal waste problem more amenable to source control than to collection and treatment.

Accumulated manure piles can constitute a major source of water pollution; however, at the present time, most animal production is dispersed in individual farms and confined to a manageable number of animals. Runoff from animal sheds and corrals can be prevented by use of ditches--around the periphery of the sheds--leading to holding ponds and/or into irrigation head ditches. Storage ponds with enough capacity to capture runoff from a 10-year storm are suggested.

Manure-spreading on the land can be another potent source of polluted runoff; however, a recent study (Reference 11-6) concluded that pollution of surface streams from animal wastes can be reduced more than 99 percent if the wastes are spread on the land surface in a well-planned manner.

The present practice, in the study area, of spreading manure on frozen or snow-covered ground during the winter season, however, is to some extent counter-productive. During the spring these wastes will run off with the snow-melt causing water pollution rather than permeating into the ground, which may still be frozen at this time. Furthermore, during other periods of the year, the fertility and soil conditioning capacity of the manure is partially lost by the time it finally becomes incorporated into the topsoil.

The preferred timing of manure application would be in the fall, followed immediately by plowing. The organic matter would thus have adequate time to mix with the soil and decompose into readily available plant fertilizer by springtime.

A limited recycling of wasted nutrients in the manure has been tried, to a certain extent, by refeeding sterilized and processed manure to livestock as a small portion of their feed. While this practice is not yet utilized in the study area, its potential applicability should be considered in the future when waste processing is further refined and the methodology is made practicable.

WASTE TREATMENT

Waste treatment is the processing of a discrete waste stream in order to alter its physical, chemical or biological characteristics. The pollution potential of many types of wastes can be reduced by treatment, provided that they can be economically collected and conveyed to a central point for processing.

Municipal Wastewater Treatment

Treatment of municipal sewage prior to discharge has been practiced for many years. Primary treatment of sewage, that is, the screening and settling out of the larger sewage solids, has been adopted throughout the United States. Within the study area, carbonaceous oxidation in a biological system, or secondary treatment, has also been used extensively during the last two decades. It can be anticipated that increasingly stringent regulation of water quality and increased wastewater volume in the future will require the adoption of more advanced wastewater treatment systems.

Although it is not part of the purpose of this study to select specific municipal wastewater treatment process trains that will allow compliance with the water quality standards, treatment options must be described in sufficient detail to allow estimates of the costs of alternative courses of action to be made. A broad range of treatment process trains and the effluent quality that will result from them are shown in Table 11-3. It can be seen that a wide range of effluent quality can be attained using different process trains. In fact, effluent produced by the most advanced processes may be suitable for domestic water use.

TABLE 11-3

ESTIMATED EFFLUENT QUALITY FROM WASTEWATER TREATMENT PROCESS TRAINS

Treatment Process Train	Physical Characteristics			Oxygen Demand		Biostimulants		Toxicants			Bacteriological
	Susp. Solids mg/l	Turbidity JTU	Grease & Oil mg/l	BOD$_5$ mg/l	COD mg/l	Nitrogen mg/l	Phosphorus mg/l	Survival Percent	TL$_m$ Percent	Toxicity Conc. tu	Coliform MPN/100ml
1. Sedimentation & Disinfection	100	45	40	140	350	35	10	20	50	2.2	1,000
2. Sedimentation, Carbonaceous Oxidation & Disinfection	35	20	12	30	100	30	8	33	80	1.25	240
3. Sedimentation, Oxidation with Nitrification & Disinfection	20	15	8	20	75	30	8	40	90	1.1	23
4. Sedimentation, Oxidation with nitrification, filtration & Disinfection	10	10	2	10	50	30	6	80	100+	0.8	2.2
5. Sedimentation, Oxidation with Nitrification, Denitrification & Disinfection	20	15	5	20	75	3	5	80	100+	0.8	23
6. Sedimentation, Oxidation with Nitrification, Denitrification, Filtration, Sorption & Disinfection	5	3	2	5	15	3	5	90	100+	0.6	2.2
7. Lime Addition, Sedimentation, & Disinfection	25	18	8	40	100	35	2	32	75	1.33	240
8. Lime Addition, Sedimentation, Gas Stripping & Disinfection	15	10	5	25	80	8	2	40	90	1.1	23
9. Lime Addition, Sedimentation, Gas Stripping, Filtration, & Disinfection	10	5	2	25	80	8	0.2	50	100+	0.9	23
10. Lime Addition, Sedimentation, Filtration, Break-Point Chlorination	10	5	2	20	75	3	0.5	40	90	1.1	2.2
11. Lime Addition, Sed[illegible]tion, Filtration, [illegible] Ion Exchange, Sorp[illegible] Disinfection	2	1	1	10	30	2	0.2	90	100+	0.7	2.2
12. Sedimentation, Oxidation, Lime Addition, Sedimentation, Filtration, Ammonia Ion Exchange, Sorption & Disinfection	2	1	1	2	10	2	0.2	100	100+	0.2	2.2
13. Sedimentation, Oxidation, with Nitrification, Denitrification, Lime Addition Sedimentation, Filtration, Sorption, & Disinfection	2	1	1	2	10	3	0.2	90	100+	0.5	2.2

Note: Assumed inlet water quality
(Medium Strength Domestic Sewage)

Suspended Solids, mg/l	250
Grease & Oil, mg/l	100
BOD$_5$, mg/l	200
COD, mg/l	500
Total Nitrogen, mg/l	50
Total Phosphorus, mg/l	12
Coliform/100ml	10^8

For the purpose of this study, the four municipal treatment or effluent quality levels shown in Table 11-4 have been chosen for use as planning guides. These levels of effluent quality can be achieved by a number of different process trains.

Effluent quality level I is a typical secondary effluent such as might be produced by conventional trickling filter or activated sludge plants. Effluent quality level II is a high-quality nitrified or at least partially nitrified secondary effluent. Effluent quality level III is a nitrified secondary effluent from which some of the residual particulate matter has been removed. Process trains that might be used to obtain each of these levels of effluent quality are shown in Figures 11-2, 11-3, and 11-4.

The environmental benefits of level III treatment are the production of a readily disinfectable effluent with a low potential for oxygen depletion, little suspended material and with a limited toxicity. Level IV treatment results in a further diminution of negative environmental effects.

Industrial Wastewater Treatment

The quality of industrial wastewaters is so variable that a wide range of unit processes is employed in their treatment. No attempt was made in this study to analyze industrial treatment alternatives.

Treatment of Urban Runoff

While urban runoff is recognized as a potent source of pollutants, little information is available regarding its treatment. When treatment has been proposed it has usually involved storage and settling, or occasionally flotation, microscreening and chlorination. Experiments in Cincinnati, Ohio (Reference 11-7) indicated that chlorination and one-hour plain settling of urban runoff resulted in 50 percent removal of suspended solids and 23 percent removal of biochemical oxygen demand.

Detention basins have been considered in Salt Lake City as a means of controlling floods and siltation of the river (References 11-8 and 11-9). It is estimated that a dual-purpose system of this type could be operated and maintained at a lesser cost than the present cost of silt removal by dredging.

Treatment of Agricultural Wastewaters

As in the case of urban runoff, little information is available regarding treatment of agricultural wastes, particularly irrigation wastewaters.

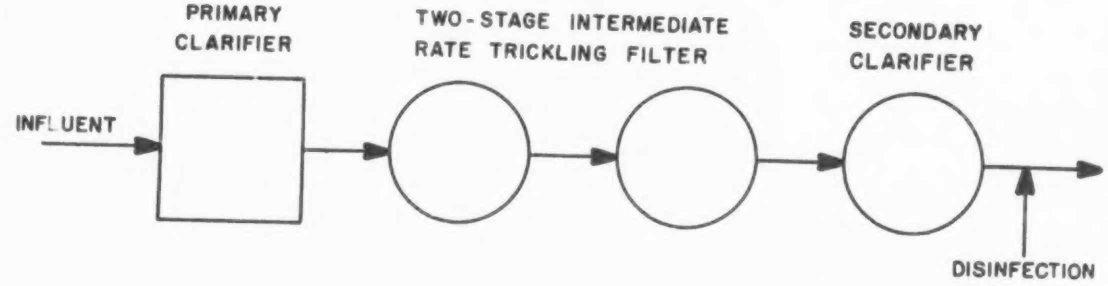
TABLE 11-4

ESTIMATED EFFLUENT QUALITY FROM WASTEWATER TREATMENT PROCESS TRAINS

Treatment Level	Description	Physical Characteristics			Oxygen Demand		Biostimulants		Toxicants			Bacteriological
		Susp. Solids mg/1	Turbidity JTU	Grease & Oil, mg/1	BOD_5 mg/1	COD mg/1	Nitrogen mg/1	Phosphorus mg/1	Survival Percent	TL_m Percent	Toxicity Conc. tu	Coliform MFN/100ml
I	Sedimentation, carbonaceous oxidation, chlorination	35	20	12	25	100	30	8	33	80	1.25	1,000
II	Sedimentation, carbonaceous oxidation, nitrification, chlorination	20	15	8	20	75	30	8	40	90	1.1	240
III	Sedimentation, carbonaceous oxidation, nitrification, filtration, chlorination	10	10	2	10	50	30	6	80	100+	0.8	2.2
IV	Sedimentation, carbonaceous oxidation, nitrification, filtration, carbon adsorption, chlorination	5	5	1	5	30	30	5	90	100+	0.6	2.2

Note: Assumed inlet water quality
(Medium Strength Domestic Sewage)

Suspended Solids, mg/1	250
Grease & Oil, mg/1	100
BOD_5, mg/1	200
COD, mg/1	500
Total Nitrogen, mg/1	50
Total Phosphorus, mg/1	12
Coliform/100ml	10^8


PRIMARY CLARIFIER
TWO-STAGE INTERMEDIATE RATE TRICKLING FILTER
SECONDARY CLARIFIER
INFLUENT
DISINFECTION

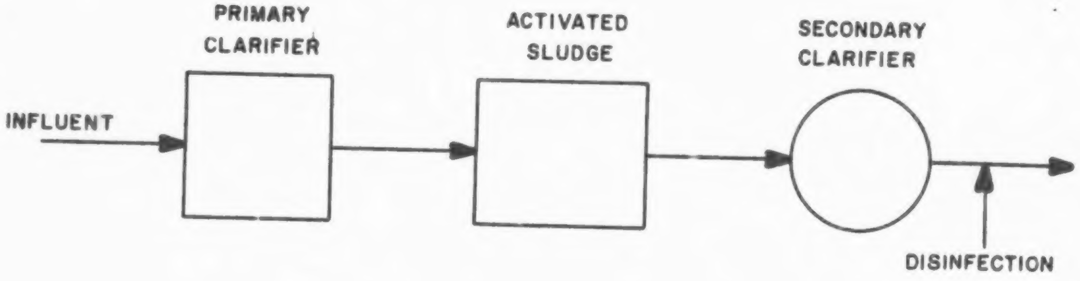

PRIMARY CLARIFIER
ACTIVATED SLUDGE
SECONDARY CLARIFIER
INFLUENT
DISINFECTION

FIGURE 11-2 PROCESS TRAINS PRODUCING LEVEL II EFFLUENT

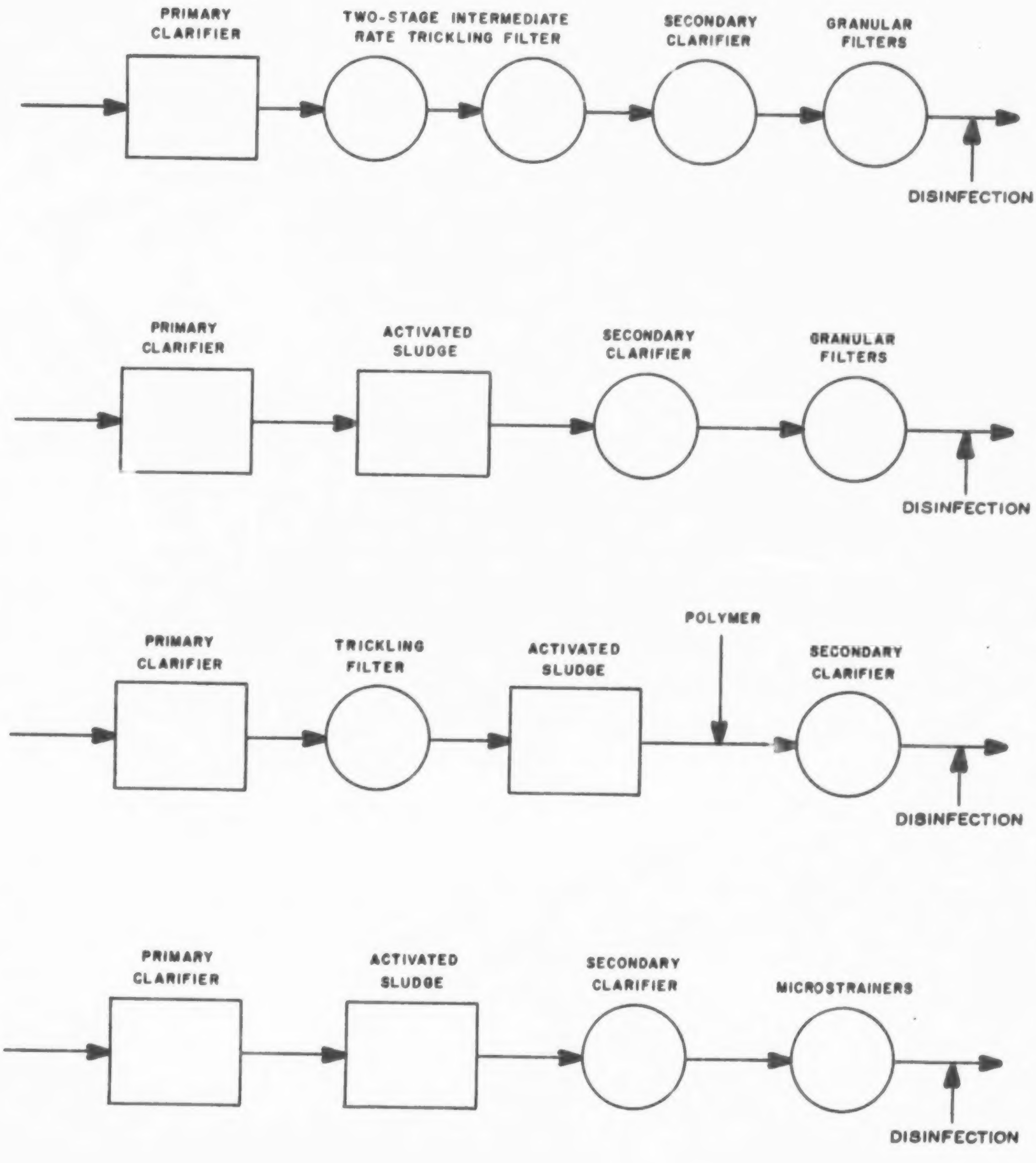

PRIMARY CLARIFIER
TWO-STAGE INTERMEDIATE RATE TRICKLING FILTER
SECONDARY CLARIFIER
GRANULAR FILTERS
DISINFECTION
PRIMARY CLARIFIER
ACTIVATED SLUDGE
SECONDARY CLARIFIER
GRANULAR FILTERS
DISINFECTION
PRIMARY CLARIFIER
TRICKLING FILTER
ACTIVATED SLUDGE
POLYMER
SECONDARY CLARIFIER
DISINFECTION
PRIMARY CLARIFIER
ACTIVATED SLUDGE
SECONDARY CLARIFIER
MICROSTRAINERS
DISINFECTION

FIGURE 11-3 PROCESS TRAINS PRODUCING LEVEL III EFFLUENT

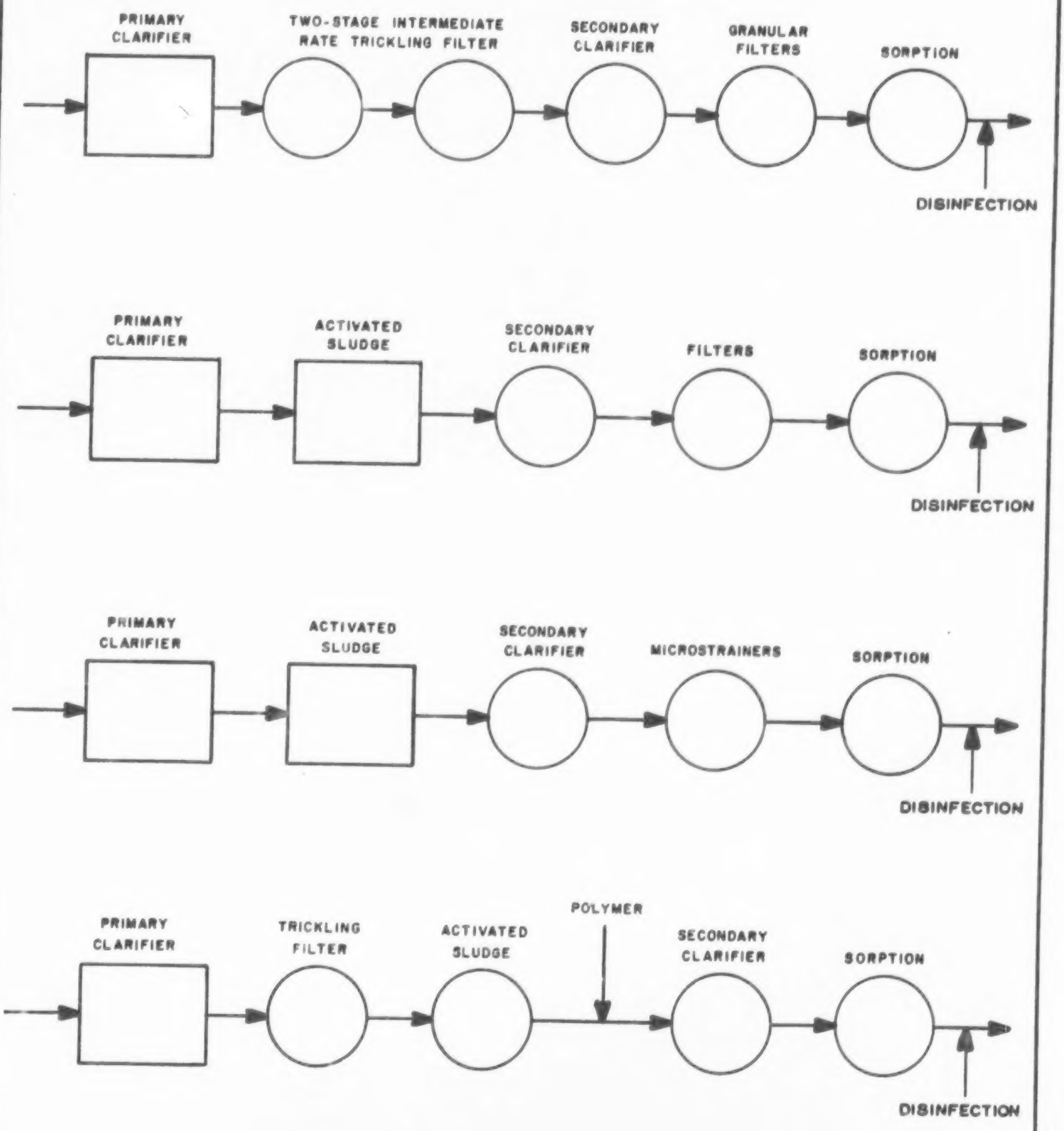

PRIMARY CLARIFIER
TWO-STAGE INTERMEDIATE RATE TRICKLING FILTER
SECONDARY CLARIFIER
GRANULAR FILTERS
SORPTION
DISINFECTION
PRIMARY CLARIFIER
ACTIVATED SLUDGE
SECONDARY CLARIFIER
FILTERS
SORPTION
DISINFECTION
PRIMARY CLARIFIER
ACTIVATED SLUDGE
SECONDARY CLARIFIER
MICROSTRAINERS
SORPTION
DISINFECTION
PRIMARY CLARIFIER
TRICKLING FILTER
ACTIVATED SLUDGE
POLYMER
SECONDARY CLARIFIER
SORPTION
DISINFECTION

FIGURE 11-4 PROCESS TRAINS TO OBTAIN LEVEL IV EFFLUENT

The diffuse nature of the waste source and the economic context of agricultural activities make collection and treatment of agricultural wastewater difficult and expensive.

An exception is treatment of feedlot wastes where the waste is confined to a relatively small area. Effective treatment methods include lagooning and composting.

RELOCATION OF DISPOSAL SITES

The environmental impact of a waste discharge may be modified by altering the point at which the discharge is made. Two principal factors are pertinent to the selection of disposal sites: (1) the sensitivity of the environment at the disposal site to the effects of wastewater discharge and (2) the dispersion or mixing capacity of the receiving environment.

Thus the detrimental effects of a waste can be reduced by moving a discharge from a sensitive trout-spawning stream to a less sensitive sluggish and turbid stream or by moving it from an ephemeral stream to one with a substantial year-round flow.

In the study area, some benefits could be obtained by eliminating discharges from the small streams tributary to the Great Salt Lake and Utah Lake and replacing them by discharges to the open waters of the lakes by means of a submarine diffuser. This becomes a promising option, however, only if treatment level IV is necessary to meet water quality standards, because the State of Utah interim effluent standards necessitate the adoption of at least level III treatment regardless of the nature of the receiving environment.

IN-STREAM QUALITY/QUANTITY MODIFICATION

A number of measures can be taken that result in improved water quality other than those described in the preceding sections.

A measure of particular application to the study area is stream flow maintenance or augmentation. The waste assimilative capacity of a stream can be maintained at a high level by prevention of excessive diversions of flow or by supplementing natural stream waters with good quality water from another source.

In-stream water quality may be improved by certain techniques. Examples exist of in-stream mechanical aeration, hydraulic structures designed to improve aeration and even settling basins designed to clarify the entire flow of a stream. More generally accepted are chemical applications to control algal growth in lakes and reservoirs.

IMPACT OF WASTE DISCHARGES ON RECEIVING WATER QUALITY

To develop an effective water quality management plan, it is necessary to predict the effect of waste discharges on various types of receiving waters. For the purposes of this analysis, waste discharges were divided into three categories: discharges to dry stream channels, discharges to lakes, and discharges to rivers, in this case the Jordan River.

Dry streams are defined as streams which have had a recorded zero flow for a period of seven days at some time during the last ten years. Flow records for small streams of this type are usually inadequate or non-existent and consequently some judgement is necessary in identifying dry streams. In some cases small streams which might be judged to be ephemeral, on the basis of catchment area, are, in fact, fed by year-round springs.

DISCHARGE OF WASTEWATERS TO LAKES

The function of a lake waste disposal system is to convey a waste, treated to a suitable degree, to a point of final disposal where the effect of the waste on the receiving waters is minimal. By constructing and properly locating an outfall pipe terminating in a diffuser, it is possible to take advantage of natural lake processes to dilute and transport waste away from critical areas of beneficial use. The natural lake processes which must be accounted for and which may aid in waste disposal include wind-generated and littoral currents, density gradients and upwelling.

Mechanisms of Dilution and Dispersion in Lakes

When wastewaters are discharged through an outfall placed upon the lake bottom, the wastewaters will seek their own density level. Generally this means that the wastewaters will rise as a plume and then, having found their own density level, will spread horizontally with the prevailing currents.

This process may be approximated numerically by first considering the initial dilution of the wastewaters immediately following discharge through the diffuser. The initial dilution is due to jet mixing caused by acceleration through the diffuser ports. Various equations are available that take into account the correct speed, diffuser length, mixing depth and wastewater discharge rate. The dilution resulting from lateral dispersion as the initially diluted wastewater field is carried horizontally by the lake currents can also be estimated by equations which consider the travel time to the point of concern, such as a nearby beach, the diffuser length and the diffusivity of the lake.

Nonconservative materials of waste origin, such as coliform bacteria, are subject to decay in lake environments. Reduction in coliform bacteria concentration due to disappearance is generally estimated to follow an exponential decay. It has been observed that the concentration of coliforms will decay to ten percent of its initial value within several hours in a saline environment.

Therefore the combined effects of initial dilution, horizontal dispersion and dilution due to disappearance may be estimated numerically for a given waste discharge situation. The resulting values have been found to adequately reflect the complex physical processes occurring in a lake environment.

Application to the Study Area

There are two large lakes in the study area which may, at some time in the future, be considered as potential receiving waters for treated wastewaters discharged through outfalls. These are Utah Lake and the Great Salt Lake.

Utah Lake has a dissolved solids concentration of approximately the same value as treated wastewaters. Also, the temperature difference between wastewaters and the lake may be small for most of the year. Therefore the density of wastewaters can be expected to be approximately the same as the lake, and good initial mixing would occur through a properly designed outfall. In addition, due to the relatively shallow nature of Utah Lake, the currents should be sufficient to adequately disperse the waste away from the discharge area. The proximity of beaches would be a factor in outfall location.

The Great Salt Lake has a much higher density than normal treated wastewaters due to its high-salt content. Therefore, initial mixing of wastewaters may not be as good as in Utah Lake because the more bouyant wastewaters would tend to rise to the surface. However, prevailing winds in the region of Salt Lake City would tend to disperse wastewaters away from beach areas. Moreover, the high-salt content should accelerate the decay of coliform bacteria.

Thus both Utah Lake and the Great Salt Lake would be suitable for receiving treated wastewaters via outfall discharge. Surveys to establish the proper location, depth and diffuser length would be necessary to elimnate the risk of interference with beneficial uses in these lakes.

DISCHARGE OF WASTEWATERS TO DRY STREAM CHANNELS

A procedure was developed for determing the treatment required for plants discharging to streams which will be dry (zero flow) during the seven-day, ten-year recurrence interval. During these low-flow periods the effluent will become the streamflow and therefore must meet the water quality standards. The State of Utah Class "C" water quality standards specify that all streams shall have a dissolved oxygen (DO) content of not less than 5.5 or 6.0 mg/l, depending upon the temperature classification. Effluent from secondary sewage treatment plants in the study area has a dissolved oxygen content of 4 to 6 mg/l. If the dissolved oxygen content is below the standard, the effluent must be aerated to raise the level to at least that required by the standard, and furthermore to prevent subsequent development of an oxygen sag the biochemical oxygen demand content of the effluent must be limited so that deoxygenation will be exactly balanced by natural reaeration in the stream. To determine the allowable loading of biochemical oxygen demand from a treatment plant to a dry stream, the Steeter-Phelps equation can be used to represent the stream assimilation process. The Streeter-Phelps equation is:

$$\frac{dD}{dt} = k_1 (L - y) - k_2D = \text{(BOD oxygen utilization)} - \text{(reaeration)}$$

$$= k_1Le^{-k_1t} - k_2D,$$

where D = dissolved oxygen deficit

L = ultimate BOD

y = BOD at time t

k_1 = rate of deoxygenation

k_2 = rate of reaeration

t = time from point of discharge.

To maintain the oxygen deficit at its initial level, that is, now oxygen depletion below the water quality standard, the rates of deoxygenation and reaeration must be equal. In other words, for no oxygen sag curve to develop, the above equation can be solved for L with $dD/dt = 0$, resulting in

$$L=\frac{k_2}{k_1} De^{k_1 t}.$$

By assuming that the five-day BOD is two-thirds the ultimate BOD and solving the above equations for initial conditions at the point of discharge, i.e., $t = 0$ and D_a = initial oxygen deficit, the following equation is produced:

$$BOD_5 = 0.67 \frac{k_2}{k_1} D_a$$

The ratio of k_2/k_1 is dependent upon stream conditions and the nature of the discharged waste, and D_a is primarily dependent upon the wastewater effluent temperature. The water quality criteria for temperature specify that cold water streams shall be maintained at 68°F and warm water streams at 80°F unless natural conditions are higher. Using these temperatures as representative of cold and warm water streams and assuming the DO of the discharge was at 5.5 mg/l for warm water streams and 6.0 mg/l for cold water streams, the initial oxygen deficits would be 2.5 mg/l and 3.0 mg/l for warm and cold water streams, respectively. These values were used in the above equation to compute the allowable BOD_5 loadings for different ratios of k_2/k_1. These values are shown in Figure 11-5. or example, if a small warm water stream had a k_2/k_1 ratio of 7.5, the allowable BOD loading would be 10 mg/l. Referring to Table 11-4, this could be met by application of level III treatment.

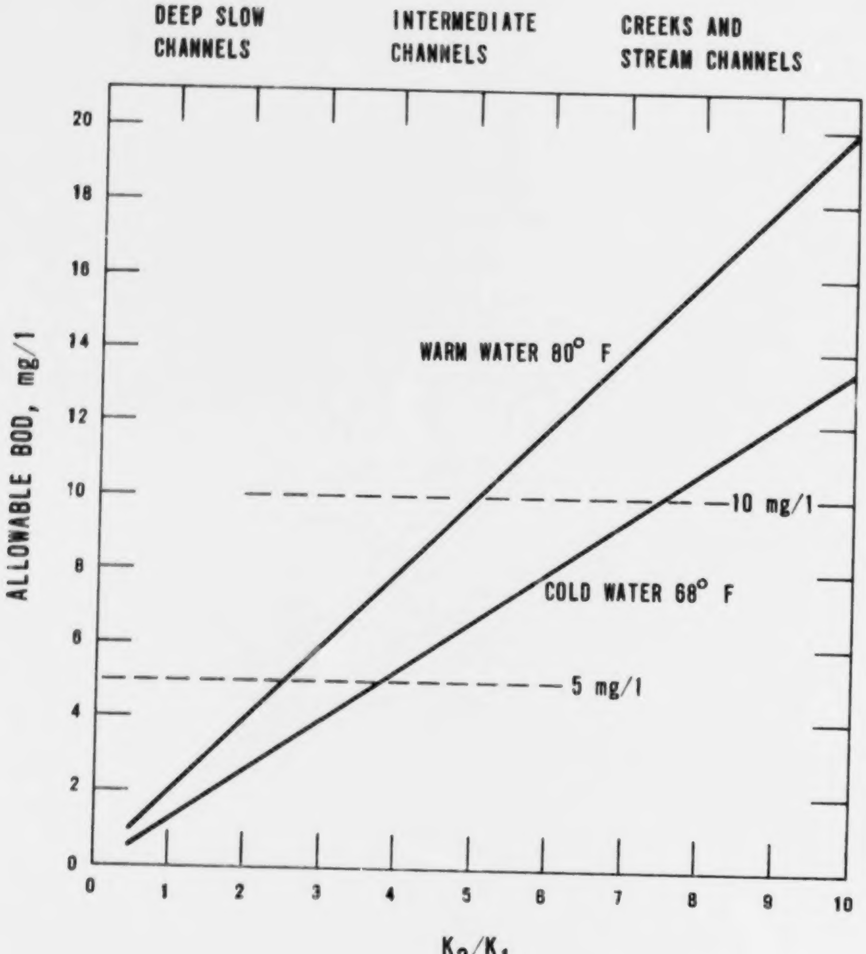


FIGURE 11-5 ALLOWABLE BOD IN DISCHARGES TO DRY STREAM CHANNELS

DISCHARGE OF WASTEWATERS TO FLOWING STREAMS

When the effluent from a treatment plant is discharged into a stream, several changes in the waste quality and reactions with the receiving environment may occur simultaneously. First the waste will be diluted by the stream flow. In a large river it may take several miles for the waste to diffuse uniformly across the stream cross section. Additionally, due to differences in stream velocities at different points in the river, the waste will be dispersed or spread longitudinally along the course of the river downstream of the discharge. Because both stream flow and wastewater flows change with time, the dilution by diffusive and dispersive mechanisms never reaches a steady state, i.e., changes in concentration of a pollutant at a given point in a river are expected. For example, variations of ± 25 percent in concentrations of dissolved oxygen, biochemical oxygen demand, nitrogen forms and other parameters have been observed in the Jordan River in the space of a few days.

In addition to physical dilution of waste discharges, various biochemical reactions occur and have an effect on those materials which are nonconservative such as biochemical oxygen demand. They may involve waste settling out or decay due to die-away, as in the case of solids and coliforms, respectively. Complex reactions involving the interaction of the waste material and the receiving environment will occur. For example, the change in concentration of dissolved oxygen in the stream is a direct function of the difference between BOD oxygen utilization and reaeration from the atmosphere.

Fortunately mathematical equations, computer programs and other analytical tools have been developed to assist the engineer in evluation the results of these dilutions and reactions, thereby enabling reasonably precise prediction of the water quality in a stream under a particular waste management option.

Development of the Jordan River Water Quality Model

It is apparent from the water quality data for the Jordan River that a serious pollution problem is the low levels of dissolved oxygen content that occur, particularly during low-flow periods in the summer. In order to evaluate the effect of waste management alternatives on the dissolved oxygen resources of the river, a generalized water quality model was applied. Prior to the use of the model as an evaluative tool it was necessary to calibrate the model to the Jordan River and then verify that it functions with acceptable accuracy. This section describes the process of model development, model calibration and model verification.

A mathematical-computer model was applied to the Jordan River. The model is an adaptation of QUAL-1, which was first developed by the Texas Water Quality Development Board and has since been applied throughout the United States. The model is basically a Streeter-Phelps formulation for a multiple-source, branching river system. Input to the computer program consists of a physical description of the river system (inflows, withdrawals and length of each reach), the hydraulics (flow and velocity) and reaction rates k_2 and k_1 for each reach of the river. Eleven reaches of the river, each broken down into one-half mile elements, were used to model the Jordan River. Given a particular waste loading pattern (location, flow, dissolved oxygen and biochemical oxygen demand concentrations) and prevailing water temperatures, the computer program computes steady-state average biochemical oxygen demand and dissolved oxygen at one-half mile intervals along the river. Output is in a tabular form and has a graphical profile. A more complete description of the model and an excellent users manual for the computer program are given in two EPA reports (References 11-10 and 11-11).

Model Calibration--

With the assistance of Meta Systems, Inc. the modified version of QUAL-1 was calibrated to the Jordan River. Water quality and waste loading data were available from STORET for the month of August 1972. Additionally, velocity and flow measurements were available for several days during that month and were used to establish the hydraulic characteristics of the river. The average flows during that month, as used in the model, were adapted from an EPA study of the Jordan River (Reference 11-12) and are shown in Figure 11-6. Flows during that month are typical of the low-flow periods for the Jordan River.

Not all model input requirements could be satisfied by the available data. These variables or model calibration parameters were used to adjust the model output to agree with the observed average dissolved oxygen profile

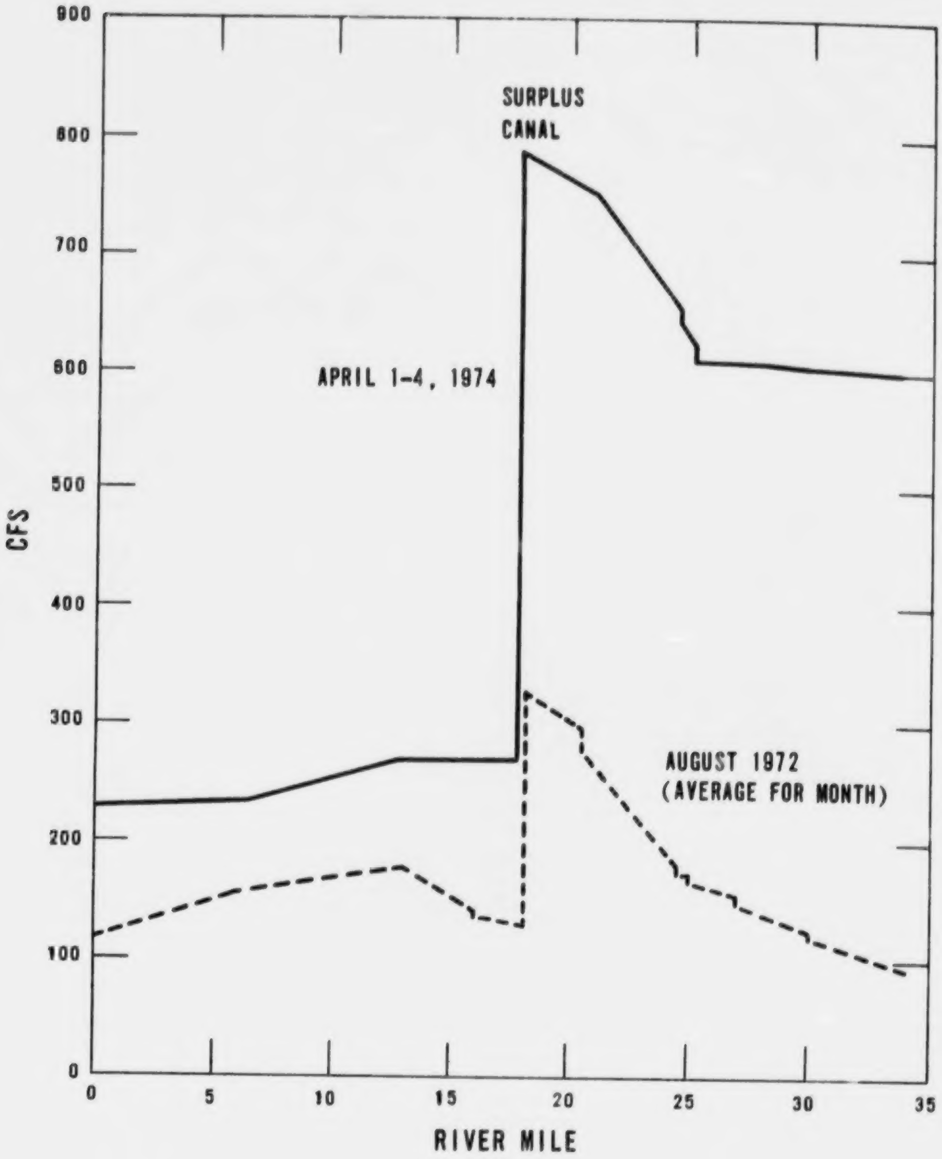


FIGURE 11-6 JORDAN RIVER WATER BALANCE FOR WATER QUALITY MODEL

for August 1972. They were as follows:

1. Velocities in ungaged reaches
2. Deoxygenation coefficient, k_1, for each reach
3. Reaeration coefficient, k_2, for each reach
4. Dissolved oxygen and biochemical oxygen demand of tributary creeks and other sources of runoff

These values were initially estimated using values and formulas from the technical literature. Initial calibration runs with the model resulted in predicted values of dissolved oxygen and biochemical oxygen demand which were too high. This was interpreted to mean that the biochemical oxygen demand was not being exerted at a fast enough rate or that the residence time in the river was too short. Adjustments were made to k_1 (increased), k_2 (decreased) and velocities (decreased) in the 11 reaches to adjust the model output to agree with the observed biochemical oxygen demand and dissolved oxygen profile. After several tries, the agreement was judged to be as good as could be expected. The results of the calibration are shown in Figure 11-7. The values of the input data and final values of the calibration parameters are presented in Appendix 11-A.

Model Sensitivity--

Prior to use of the water quality model as a predictive tool, it is useful to understand how sensitive the model output is to changes in key variables. This is particularly important with regard to identifying data gaps for future attempts at verifying the model and for developing waste management alternatives which will improve water quality in the Jordan River.

Shown in Table 11-5 are the resulting changes in the minimum level of dissolved oxygen in the Jordan River created by specified changes in the values of key variables, leaving all other input data unchanged. For example, eliminating municipal waste flows from the Jordan River will raise the minimum dissolved oxygen by 42 percent or to just under 5 mg/l for the test case. Consequently, the biochemical oxygen demand in urban runoff and agricultural return flow as a source of pollution cannot be ignored. It is difficult to measure all runoff dissolved oxygen and biochemical oxygen demand entering the Jordan River because much of it enters as

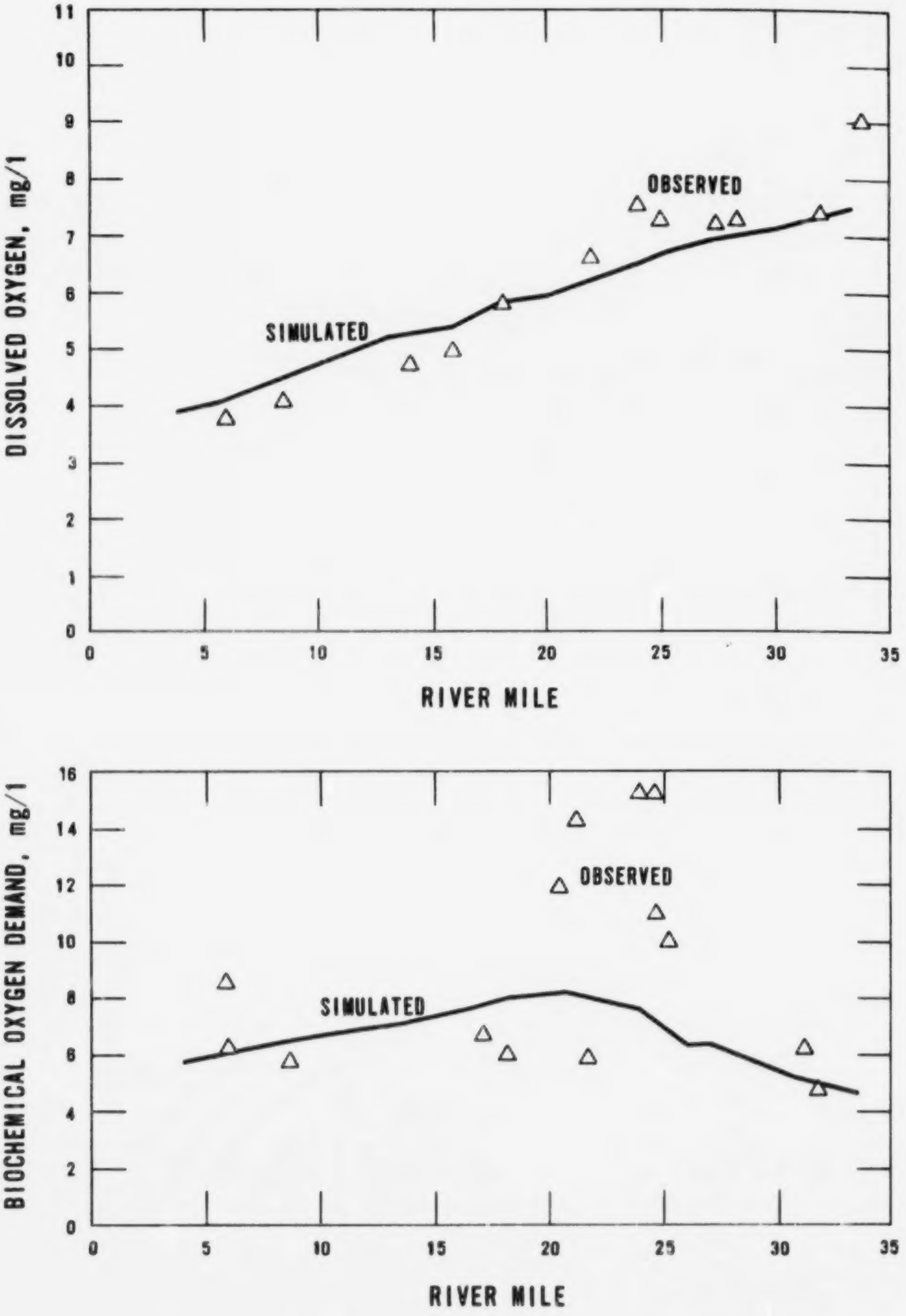


FIGURE 11-7 JORDAN RIVER WATER QUALITY MODEL: CALIBRATION TO AUGUST 1972 DATA

TABLE 11-5

JORDAN RIVER WATER QUALITY MODEL SENSITIVITY ANALYSIS RESULTS

Variable	Calibration Value	Change in Value, %	Change in Minimum DO from Calibration Value, %
Waste Load	5.0 mg/l	-60	- .6
Dissolved Oxygen	5.0 mg/l	+40	+4
Waste Flows	Varies	-100	+42
Runoff	7.0 mg/l	-43	-18
Dissolved Oxygen	7.0 mg/l	+43	+21
Reaeration Rate	(.4-.6)	+100	+44
	per day	-50	-50

agricultural surface return flow and as groundwater. The model is sensitive to changes in the reaeration rate and this indicates the need to properly calibrate and verify the model rather than relying upon values in the published literature for these variables. It can be concluded from this analysis that, once the model has been calibrated, it is most sensitive to municipal waste loading followed by natural runoff waste loading and that waste management schemes designed to reduce these loadings would significantly improve water quality in the Jordan River.

Model Verification--

An essential element of the model development process is to verify that the model will reproduce, with acceptable accuracy, the dissolved oxygen/biochemical oxygen demand in the Jordan River under conditions different from those used to calibrate the model. For this reason, EPA understood a comprehensive monitoring program during 1-5 April 1974. The flow and quality of the Jordan River at 13 stations and of all its tributary waste discharges and creeks were monitored once per day during a Monday-Friday period. Flow and quality were observed to characteristic of the first spring highwater due to the melting snow and the break in an ice dam at the outlet from Utah Lake.

Data for the week of 1-5 April 1974 were averaged and prepared as input data to the model. Biochemical oxygen demand concentrations for

Cottonwood and Mill creeks were not measured; a value of 3 mg/l, the same as used to calibrate the model to the August 1972 data, was assumed. The initial model run gave predicted biochemical oxygen demand between 3.1 and 4.0 mg/l, as opposed to measured biochemical oxygen demand of 2.5 to 5.6 mg/l. This discrepancy was probably due to resuspension of previously settled material during the low-flow periods of the water and/or a higher biochemical oxygen demand concentration in Cottonwood and Mill Creeks. Because the former phenomenon could not be handled in the model, the concentration of the tributary creeks was changed to 15 mg/l, still areasonable value, and the biochemical oxygen demand agreement was greatly improved. Data used to verify the model are included in Appendix 11-A.

Results of the predicted and observed dissolved oxygen and biochemical oxygen concentrations is not as good as for biochemical oxygen demand. However, this is not unusual because the model was calibrated to conditions at the other end of the Jordan River flow and water quality spectrum. Furthermore, the once-per-day samples may not have been representative of steady-state conditions in the Jordan River and its inflows. In addition, there have been recent reports of high-chloride concentrations in the Jordan River which would lower the saturation value of dissolved oxygen and the predicted dissolved oxygen by possibly .5 mg/l.

Accuracy of the dissolved oxygen model can be considered to be within 10 percent. Although further data collection and model calibration/verification would probably reduce the margin of error below 10 percent, this level is considered acceptable for planning purposes and the model can be used with confidence that predicted values of dissolved oxygen under various waste management options are sufficiently accurate for the comparison of relative cost-effectiveness.

Follow-up work conducted by the Water Research Laboratory at Utah State University generally confirmed the results of the Meta Systems/Engineering-Science modeling effort. It should be noted, however, that both models have limitations particularly with respect to benthic oxygen demand, nitrogenous oxygen demand and, the relative contribution of non-point source pollutants.

WATER QUALITY ANALYSIS AND WASTE LOAD ALLOCATION

The previous section described the models used to preduct water quality in rivers and lakes as they are influenced by wastewater discharges. This section described the application of these models to water courses in the study area and their implications for water pollution control.

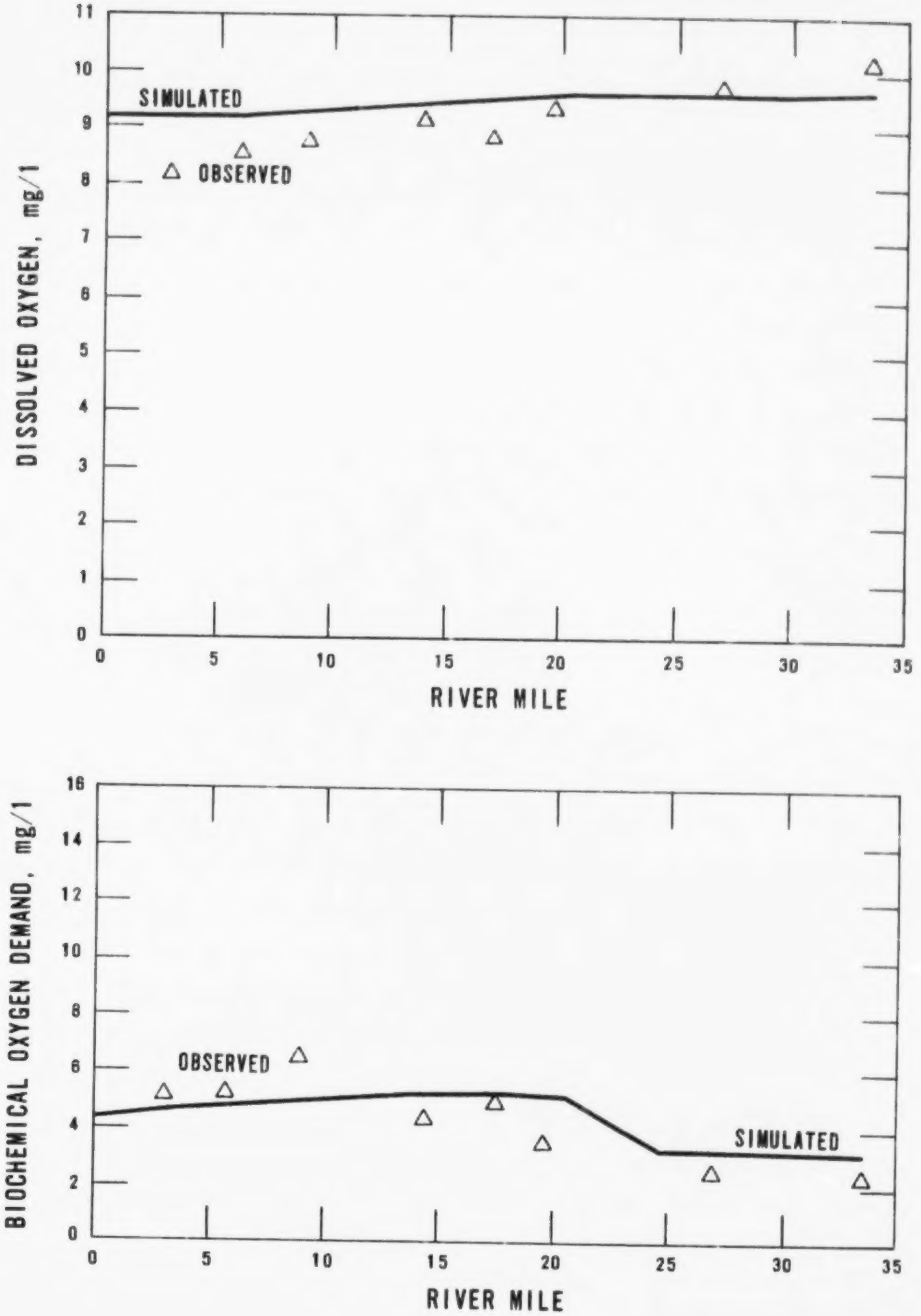


FIGURE 11-8 JORDAN RIVER WATER QUALITY MODEL: VERIFICATION WITH APRIL 1-5, 1974 DATA

Davis County

Both the North Davis and Central Davis wastewater treatment plants discharge effluent to small streams that flow to the Great Salt Lake. No flow information is available for either stream, but comparison with similar small creeks in the area that are metered suggests that the critical low flow is zero or close to zero. Thus both discharges can be regarded as discharges to dry streams.

If these discharge locations are to be retained, an effluent BOD in the range of 5 to 10 mg/l will ensure that the dissolved oxygen content of the stream waters will not be depleted as a result of waste discharge. In fact, since the stream is short and the travel time to the Great Salt Lake is brief, a somewhat higher effluent BOD probably could be discharged without causing a considerable oxygen sag to develop.

Utah's interim standards require an effluent BOD of 10 mg/l, which will probably allow compliance with the Class "C" dissolved oxygen standards; thus the 1980 waste load allocations for North and Central Davis are based on this effluent standard. A subsequent water quality monitoring program will provide the information needed to refine the waste load allocations and determine whether further treatment may be necessary.

Both South Davis North and South Davis South treatment plants discharge effluent to the lower reaches of the Jordan River. The North plant discharges to that point of the River that is diverted to Farmington Bay. The critical low-flow rate, as recorded at Cudahy Lane near the South Davis South plant is 82 cfs, which clearly provides a considerable degree of dilution water; however, during the low-flow condition, the dissolved oxygen content of the river waters at this point is already depressed below the water quality standards. The Jordan River water quality simulation model indicates that, even if upstream point sources of pollution are eliminated, dissolved oxygen content of the lower reaches will remain sub-standard during low-flow periods. Thus, it is apparent that application of high levels of treatment at the two South Davis plants will not result in a substantial improvement in river water dissolved oxygen content. Hence it seems appropriate to relate the waste load allocations to the Utah interim effluent standards and to suggest that a revised dissolved oxygen content standard be promulgated for the Lower Jordan that is better suited to the nature of the waterway.

Salt Lake County

At the present time, approximately one-half of the wastewaters generated in the Salt Lake Valley are tributary to the Salt Lake City Treatment Plant and are discharged after treatment to the Sewage Canal, which flows to the Great Salt Lake. The remaining half is treated at seven waste treatment facilities and discharged to a 14-mile reach of the Jordan River between 94th and 21st South. By 1995, the proportion of waste generated that will be discharged to this upper reach of the river will have risen to 63 percent and will have more than doubled in volume.

During low-flow periods, water quality in the Jordan River is severely impaired downstream of, and within, the reach receiving the waste discharges as described in Chapter 10. It is apparent that the water quality standards in the Jordan River cannot be met with the existing arrangements for municipal waste disposal even during periods when river flow volume is considerably in excess of the estimated ten-year minimum. In addition, since the volume of waste discharged to the river is expected to double in the next 20 years, greater levels of waste treatment will be necessary just to maintain the status quo. Using organic material (BOD) as an example, if the present waste discharges have an effluent BOD of 30 mg/1, then to maintain the same mass emission rate effluent BOD must be reduced to 13.8 mg/1 by 1995.

The Jordan River simulation model was used to predict the river water dissolved oxygen content that would result from the adoption of different degrees of waste treatment and consolidation of municipal treatment facilities. Flow rates used in the model were those measured in August 1972, which represent a slightly above average summer low flow. A comparison of these flows with an estimated ten-year, seven-day low flow is shown in Table 11-6. It is assumed that improved regulation of the river and control of excessive diversions will prevent extreme low flows in the future. An estimated minimum acceptable low-flow rate is also shown in Table 11-6.

Figure 11-9 shows the dissolved oxygen profiles that would result from different effluent quality levels using 1995 wastewater flows. Figures 11-10, 11-12, and 11-13 show dissolved oxygen profiles that would result from combinations of improved treatment and consolidation of treatment facilities.

FIGURE 11-9 SIMULATED D.O. PROFILES RESULTING FROM DIFFERENT EFFLUENT TREATMENT LEVELS

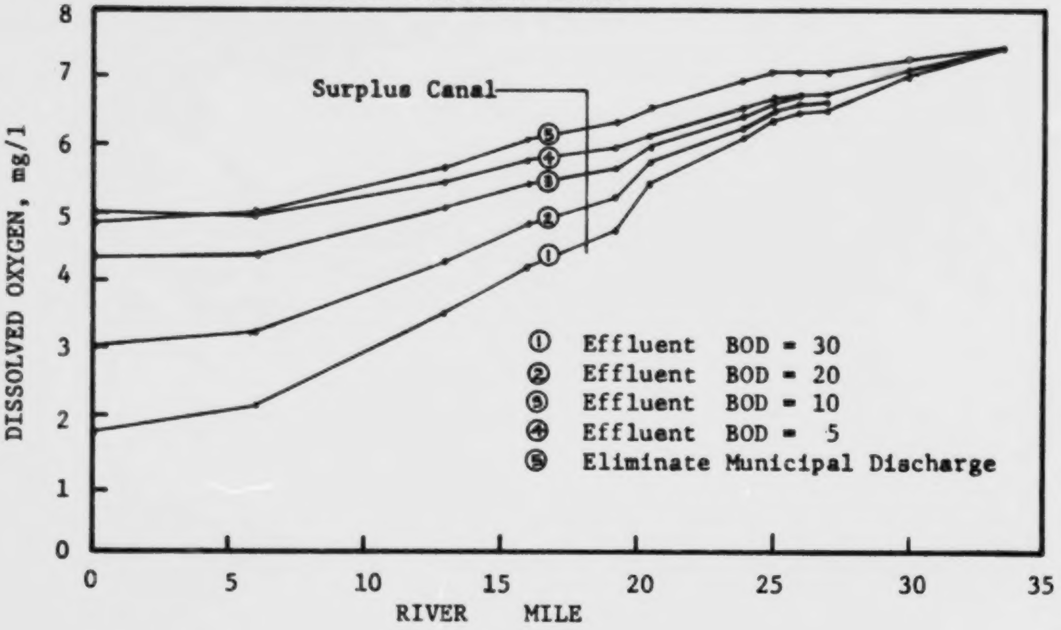
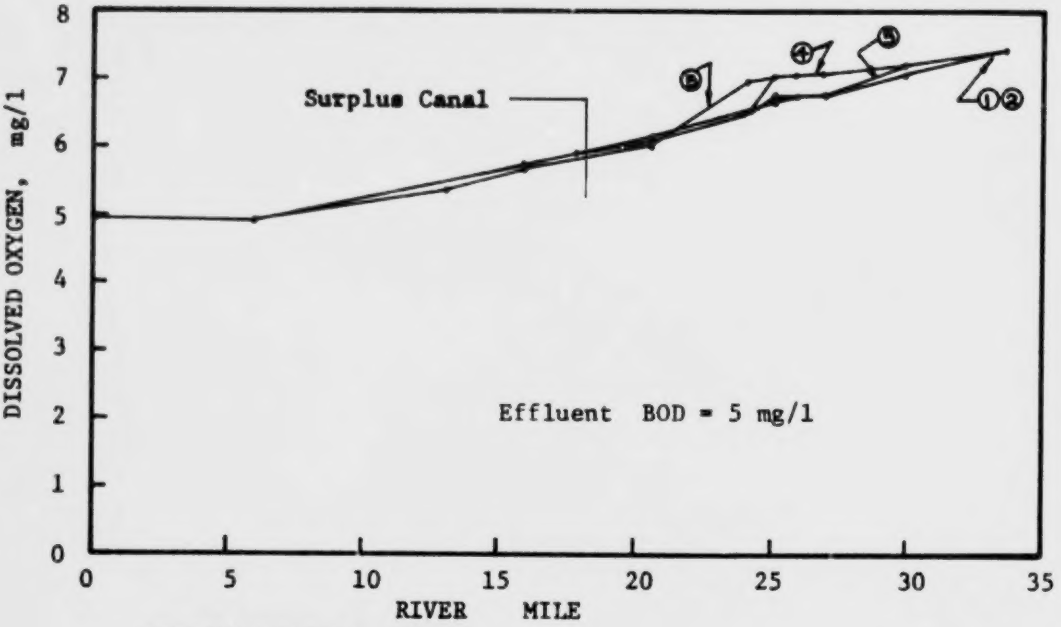


FIGURE 11-10 SIMULATED D.O. PROFILES - DIFFERENT DEGREES OF REGIONALIZATION



REGIONALIZATION LEVEL

① No regionalization
② S. Davis S. to SLC; discharge to river eliminated
③ 4 Plants at Tri-Community, Cottonwood, SLCSSD #1 & SLC
④ 3 Plants at Cottonwood, SLCSSD #1 & SLC
⑤ 2 Plants at SLCSSD #1 & SLC

FIGURE 11-11 SIMULATED D.O. PROFILES - DIFFERENT DEGREES OF REGIONALIZATION

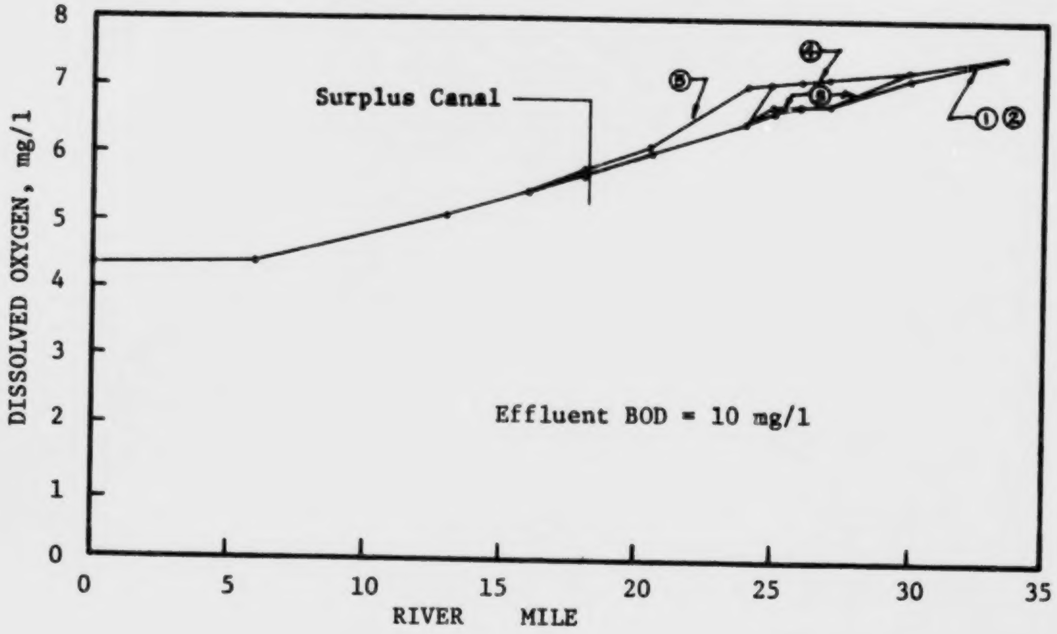


FIGURE 11-12 SIMULATED D.O. PROFILES - DIFFERENT DEGREES OF REGIONALIZATION

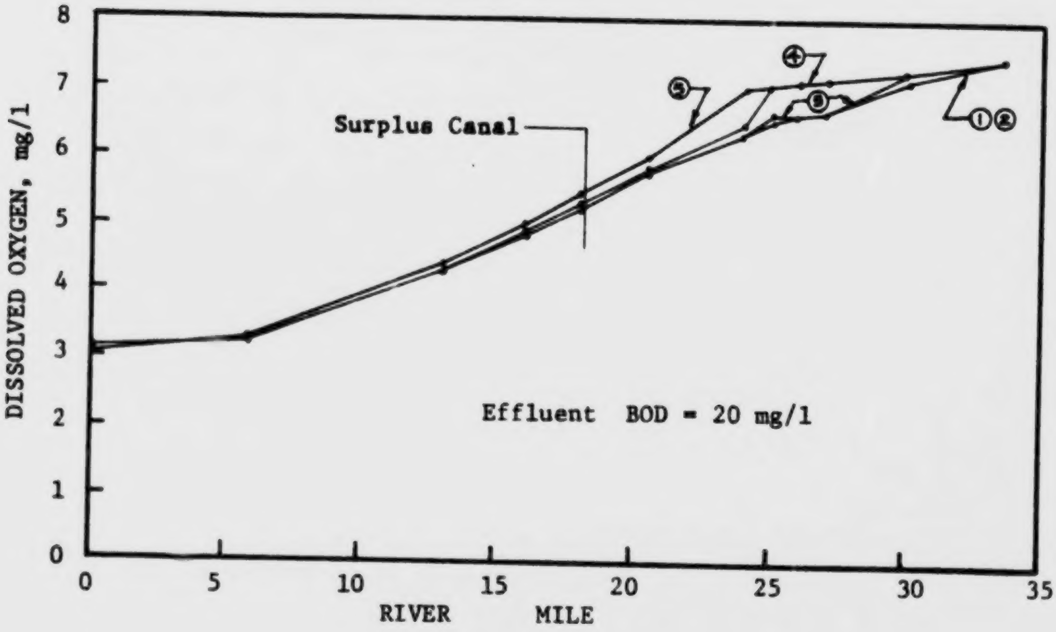


Table 11-6

JORDAN RIVER FLOWS

Location	August 1972	Estimated 10-year, 7-day low	Estimated minimum acceptable low flow rate
	cfs		
90th South	18	0.5	50
58th South	200	71	100
21st South (above Surplus Canal)	392	97	100
21st South (below Surplus Canal	139	10	100

As might be expected, the dissolved oxygen content of the stream waters increases with increase in treatment level. However, elimination of municipal discharge still does not raise the dissolved oxygen content in the lower reaches of the Jordan to the water quality standard of 6.0 mg/l. Regionalization of wastewater treatment at a plant near the Salt Lake City Suburban Sanitary District No. 1 plant results in some upstream water quality improvement.

It appears that high levels of municipal wastewater treatment alone cannot obtain compliance with water quality standards. However, the best river water quality results from complete elimination of municipal discharges, followed by regionalization of level IV treatment at the Salt Lake City Suburban Sanitary District No. 1 plant and discharge to the river at that point.

For the purpose of developing and selecting a municipal wastewater management alternative, the waste load allocations were, however, based on level III treatment for the following reason. The natural state of the Jordan River in its lower reaches is such that massive investment in upgrading treatment from level III to level IV, with a concomitant increase in downstream river water dissolved oxygen content of 0.5 mg/l, probably would not result in any significant environmental benefit.

Utah County

All the municipal wastewater discharges in Utah County, with the exception of the American Fork discharge, are made to small ditches or streams with a critical low-flow rate of zero or close to zero, which can, for analytical purposes, be regarded as dry streams. Treated wastewater from American Fork is discharged at the edge of Utah Lake.

If the existing discharge locations are to be maintained, an effluent BOD in the range of 5 to 10 mg/l will avoid oxygen depletion of the stream waters. Thus the 1980 waste load allocations for Utah County are based on the Utah interim effluent standard of 10 mg/l BOD.

In some cases the probability of compliance with water quality standards, assuming the adoption of level III treatment, is greater than in others. At American Fork the discharge to the edge of the lake ensures some degree of dispersion, while at Payson and Salem, where discharge volumes are small, the presence of a minimal year-round base flow in Bear Creek provides some measure of dilution.

Wasatch County

Effluent from the Heber City treatment plant is discharged to Spring Creek, a tributary of the Upper Provo River that has an estimated critical low flow of less than 1 cfs. If discharge is to be maintained at this location, effluent BOD must be reduced to 5 to 10 mg/l.

Estimated critical low flow of Snake Creek, the recipient of the Midway treatment plant effluent, is 8 cfs. In view of the small volume of the Midway discharge, it is expected that dissolved oxygen content standards can be met in Snake Creek with level II treatment. Utah interim effluent standards require the adoption of level III treatment by 1980; however, both the Heber and Midway treatment plants discharge wastes upstream of Deer Creek Reservoir, one of Salt Lake City's water supply sources. Since Deer Creek Reservoir is already plagued by nuisance algae in the late summer months, it is clearly desirable to reduce the input of nutrients to the reservoir. A preliminary analysis suggests that municipal wastewaters may be responsible for approximately 40 and 25 percent of the total nitrogen and phosphate inputs to the reservoir, proportions that would increase with increased municipal wastewater flows. Pending the results of a more detailed analysis, it was assumed that nutrient removal is necessary upstream of the reservoir.

WASTE LOAD ALLOCATIONS

Waste load allocations for all municipal point sources in 1980 are shown in Table 11-7, together with a subjective assessment of the probability of compliance with Class "C" standards.

TABLE 11-7

MUNICIPAL WASTE LOAD ALLOCATIONS AND TREATMENT LEVELS

Source	Effluent Quality BOD, mg/1	Waste Load Alloc. BOD, lbs/day	Required Treatment Level	Probability of Compliance with W. Q. Standards
Davis County				
North Davis	10	1,418	III	Good
Central Davis	10	300	III	Good
South Davis North	10	416	III	Fair
South Davis South	10	150	III	Poor [b]
Salt Lake County				
Sandy City	10	234	III	Fair
Tri-Community	10	827	III	Fair
Murray City	10	284	III	Poor [b]
Salt Lake County, Cottonwood	10	660	III	Poor [b]
Granger-Hunter I. D.	10	768	III	Poor [b]
Salt Lake City SSD #1	10	1,142	III	Poor [b]
South Salt Lake City	10	451	III	Poor [b]
Salt Lake City	10	3,160	III	Poor [b]
Utah and Juab Counties				
Lehi City	10	67	III	Fair
American Fork	10	125	III	Good
Pleasant Grove	10	108	III	Fair
Orem	10	342	III	Fair
Provo	10	1,166	III	Fair
Springville	10	200	III	Fair
Spanish Fork	10	242	III	Fair
Salem	10	17	III	Good
Payson	10	58	III	Good
Wasatch County				
Heber City	10	166	III	Good
Midway City	10	25	III	Good

[a] Probability that application of required treatment level will result in compliance with water quality standards in the receiving waters.

[b] Receiving water already degraded by upstream discharges and runoff.

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CHAPTER 12

EVALUATION PROCEDURES

The best water quality management alternative is one that reliably protects and enhances water quality in an economic and resourceful manner.

The costs incurred by and benefits received from each water quality management alternative must be evaluated in an equitable and systematic fashion as a prerequisite to rational decision making. Some of the costs and benefits, costs of construction of treatment facilities for example, can be calculated fairly simply since society places a readily identifiable value on the labor and materials necessary for their construction and operation. Difficulties arise, however, when the less tangible aspects of the alternatives come to be evaluated. What is the value of sparkling clear stream water, a breathtaking view or the continued existence of some aquatic insect? Clearly the values placed on these elements will be as widely varied as the many individuals whose lives they affect in different ways. How can these factors be introduced into the decision-making process?

Although the evaluation or assessment of environmental impacts of proposed projects is a relatively new concept, several attempts have been made to provide a systematic assessment method. Several existing systems were considered for use in this project, including the U.S.G.S. matrix (Reference 1), the Battelle Environmental Evaluation System (References 2 and 3) and the Georgia Institute of Ecology's Optimum Pathway Matrix (Reference 4).

None of these systems is appropriate for the task at hand for several reasons. The systems are either too complex to allow meaningful participation by non-technical individuals, or they are simple and do not attempt to assess the relative importance of the factors considered. None of the systems attempts to introduce not readily quantifiable factors other than environmental impact elements. Not readily quantifiable aspects of a project's performance or feasibility must be integrated into the evaluation method. An environmentally sound project that is not financially feasible or which is subject to frequent system failure is clearly not a valid alternative.

What is needed for this project is a broad screening procedure for the comparison and ranking of water quality management alternatives, keeping the individual factors as comprehensive as possible yet manageable in number. The selection or screening procedure has to be readily understood by the members of the public or non-technical decision-making bodies who would participate in the selection of alternative projects.

The procedure developed for use as a tool in this study has the inherent weakness of subjectivity common to the previously mentioned systems; however, it is designed to provide a rational framework within which all the subjective evaluations can be made. Each water quality management alternative is evaluated with respect to four groups of factors: economics, environmental effects, feasibility and effectiveness. Economic evaluation is straightforward once a common basis for calculation has been established. Evaluation of environmental effects, feasibility and effectiveness is subjective, reflecting the preferences, prejudices and opinions of the evaluator.

The key to systematic evaluation of the not readily quantifiable factors is the development of an evaluation matrix which will serve as a basis for discussion and ratings of alternative courses of action. The evaluation matrix developed for water quality management systems is shown in Figure 12-1. The factors considered in this matrix and their role in the evaluation are discussed in the sections following the description of the economic evaluation.

ECONOMIC EVALUATION

What will the alternative water quality management systems cost and what will be their quantifiable benefits? To answer these questions it is necessary to establish a common basis for estimates of costs and benefits.

In order to estimate the cost of constructing and operating the alternative water quality management facilities it is necessary to lay out the alternative systems in sufficient detail to permit detailed costing of the system elements. Criteria for preliminary design must be established and applied uniformly to each alternative to maintain an equitable basis for estimation.

FIGURE 12-1 EVALUATION OF WASTEWATER TREATMENT ALTERNATIVES

UNWEIGHTED PARAMETERS			ALTERNATIVE		ALTERNATIVE		ALTERNATIVE		ALTERNATIVE		ALTERNATIVE		ALTERNATIVE		ALTERNATIVE	
ECONOMICS	CAPITAL COST															
	TOTAL ANNUAL COST															
WEIGHTED PARAMETERS		WEIGHT	RATING	WEIGHTED RATING	RATING	WEIGHTED RATING	RATING	WEIGHTED RATING	RATING	WEIGHTED RATING	RATING	WEIGHTED RATING	RATING	WEIGHTED RATING	RATING	WEIGHTED RATING
ENVIRONMENTAL FACTORS	FISHERIES AND AQUATIC HABITATS															
	WILDLIFE AND WILDLIFE HABITATS															
	WATER QUALITY															
	AESTHETICS															
	RECREATION															
	OVERALL RATING	▨	▨		▨		▨		▨		▨		▨		▨	
FEASIBILITY	FINANCIAL FEASIBILITY															
	PROGRAM IMPLEMENTATION															
	PROGRAM ACCEPTABILITY															
	OVERALL RATING	▨	▨		▨		▨		▨		▨		▨		▨	
EFFECTIVENESS	EFFECTIVENESS															
	SYSTEM RELIABILITY															
	SYSTEM FLEXIBILITY															
	RECLAMATION POTENTIAL															
	OVERALL RATING	▨	▨		▨		▨		▨		▨		▨		▨	

The scope of the present study does not include detailed design of facilities. Preliminary designs and layouts of alternative systems are developed to a level of detail that allows meaningful cost estimation; however, some changes will inevitably be required at a later date as a result of the detailed engineering studies which will be made during the preparation of drawings and specifications. Design criteria and other assumptions made in the development of cost estimates are described below.

Capital Costs

Construction costs of wastewater facilities comparable with those considered in this study were obtained from many sources (References 12-5 through 12-9). Cost data for sewers, pumping stations and conventional wastewater treatment plants are based on reported costs for existing facilities. Cost data for advanced waste treatment facilities are based on current experience and reports published by federal agencies and research organizations.

Cost of land for sites and right-of-way are not included in the estimates as in most cases land cost will be a small proportion of total project cost. Alternatives requiring large land areas or acquisition of land in prime locations were considered individually and land costs estimated separately.

An additional allowance of 26 percent of the construction cost is included in the capital costs to allow for construction contingencies and for legal, financing and engineering costs.

Price Escalation

Construction costs can be expected to change in keeping with changes in the national economy. The best measure of these changes is the Engineering News-Record Construction Cost Index, which is computed from prices of labor and materials in 20 cities and is based on a value of 100 in the year 1913. Figure 12-2 shows the rising trend in construction costs since 1940. It is apparent that the average annual increase in cost has risen in the last decade to six or seven percent as compared to approximately four percent per annum, the rate prevalent until the mid-sixties. Present economic trends, both national and international, suggest that the current rate of price inflation is likely to continue rather than return to its former level.

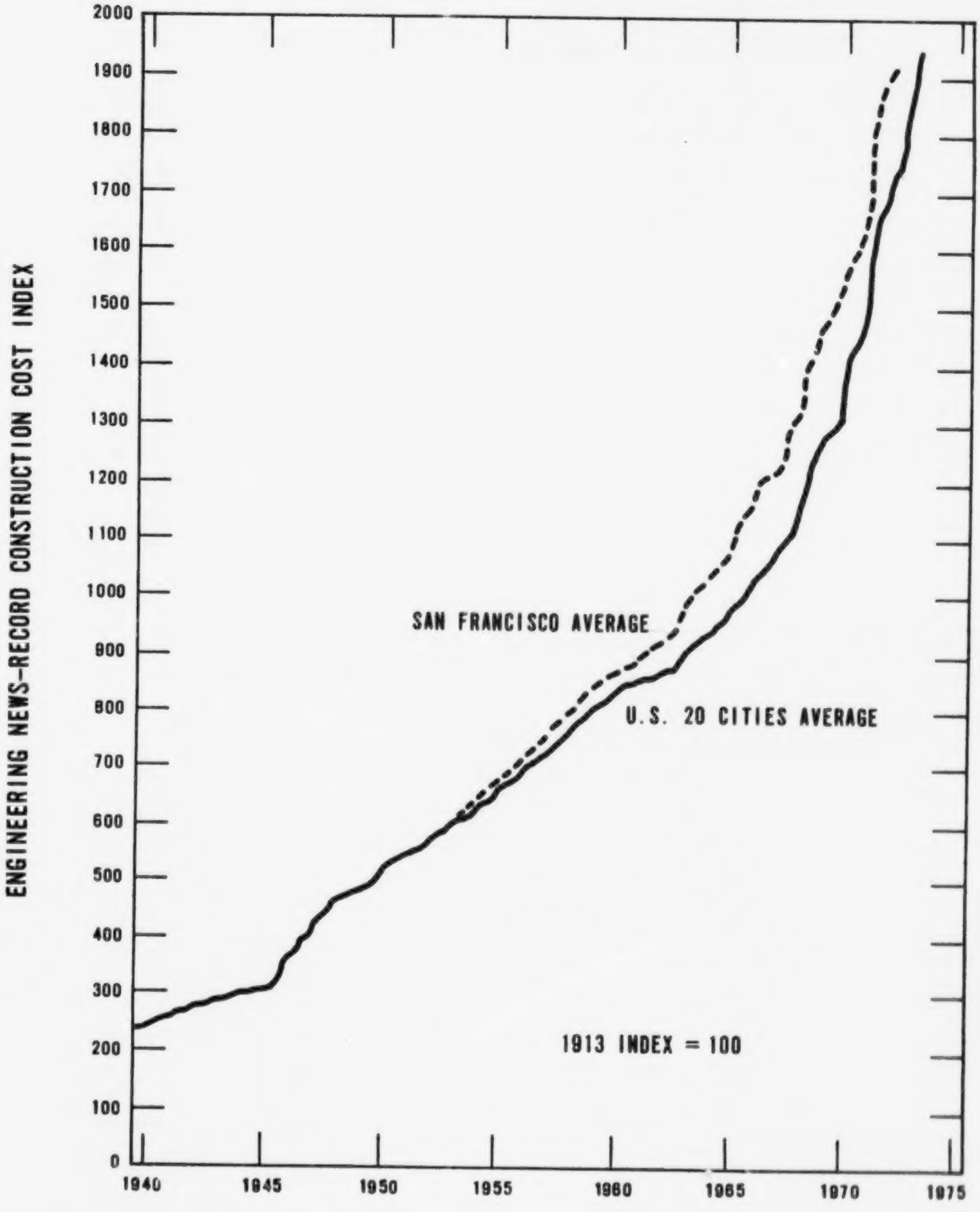


FIGURE 12-2, ENGINEERING NEWS-RECORD CONSTRUCTION COST INDEX

The 20-city average cost index now (June 1974) stands at 1920 and can be expected to exceed 2000 by the end of the year. None of the facilities recommended in the present study are likely to be built before mid-1975, when the value of the 20-city average can be expected to be 2100. Because costs in the Salt Lake City area are considered to be reasonably well represented by the 20-city average, this value is used as the basis for capital cost estimates in this study.

Annual Costs

Evaluation of alternatives requires consideration of annual costs as well as capital costs. Total annual costs include both the costs of operating and maintaining the wastewater facility and the amortization of the capital investment.

Interest Rates

Interest rates must be assumed in order to calculate the annual cost of capital and for discounting the value of deferred works in present worth comparisons.

The cost of capital varies with the state of the national economy and the money supply. Interest rates are presently at an unusually high level; the prime rate, for example, stands at 11-1/4 percent (June 1974). Although interest rates can be expected to decline somewhat from present levels, the trend of the world economy suggests that they are unlikely to return to the levels prevalent in the fifties and early sixties. Current interest rates on general obligation bonds for public financing are approximately 7 percent. This value is used in the comparison of alternatives.

Depreciation and Amortization

Even though most bonds sold for wastewater facilities will have redemption periods of 30 years or more, an estimate of the average useful life of system components is used to compute the annual cost of capital. This annual cost is calculated by applying a capital recovery factor to the total capital cost. This is the same as straight line depreciation plus annual average interest cost over the life of the project.

For the purposes of the study, treatment plants and pumping stations are assumed to have useful lives of 30 years, while sewers, siphons, force mains and outfalls area assumed to have useful lives of 60 years.

Operation and Maintenance Costs

Operation and maintenance costs include all costs for labor, power, chemicals, monitoring, administration and incidental costs involved and maintenance costs for conventional treatment plants are estimated on the basis of experience. Costs for operation and maintenance of advanced wastewater treatment facilities were obtained from the technical literature.

Design Period and Project Staging

The various components of the alternative wastewater systems considered are laid out to serve the level of development anticipated in the study area in the year 1995. Clearly, it is not necessary to construct immediately all elements of the systems sized for estimated 1995 wastewater flows. In some cases construction of facilities can be staged to meet demands as they develop. On the other hand some system components, such as tunnels, are best constructed for ultimate capacity since the cost of increasing their capacity is extremely high.

Theorectical expressions have been developed that compute optimum stage construction intervals for public works depending on interest rate and an economy-of-scale parameter. Consideration of these expressions, assuming an interest rate of 6 percent, suggests that the optimum staging interval for large wastewater treatment plants is 10 years and for trunk and interceptor sewers greater than three feet in diamter is 30 years. For the purposes of the study, all conveyance facilities and wastewater treatment plants are sized for estimated 1995 flows.

Design Criteria and Construction Costs of Interceptor Sewers

The conveyance facilities included in alternative water quality systems are laid out in sufficient detail to calculate approximate pipe sizes and determine whether they will flow by gravity.

All sewer elevations used in the report are based on U.S.G.S. mean sea level data. Sewer alignments, lengths and ground elevations were determined from U.S.G.S. topographic maps of 1" = 2,000' and 1" = 5,200' scales.

The capacity to be provided in each section of a trunk sewer or interceptor is based on the peak flow calculated for the area tributary to that section. For each area this rate is the summation of peak municipal and industrial flows plus infiltration and is known as the peak wet-weather flow. Peak factors used were as recommended in the ASCE sewer design manual (Reference 12-10).

In general, trunk and interceptor sewers are laid out to provide a minimum velocity of two feet per second when flowing full. All trunks are sized to carry their design peak flow while flowing full but without surcharge.

Capacities of existing trunk sewers and diameters of proposed trunk sewers were determined by means of Manning's pipe friction formula, using a roughness coefficient "n" of 0.012. Trunks and interceptor conduits considered in this study are assumed to be of reinforced concrete; precast pipe with rubber ring joints would be used. The maximum depth to pipe invert is 30 feet.

Construction costs for sewers are shown in Tables 12-1 and 12-2.

Force Mains and Siphons

Inverted siphons and force mains, unlike gravity sewers, always flow full. They must be designed with proper velocities to prevent deposition of solids. It is necessary in some cases to use multiple lines. In cases where conduits are carrying wastewater which has received at least primary treatment, solids deposition is not a limiting factor.

Large force mains and inverted siphons are normally constructed of concrete pipe or concrete lined and coated steel pipe. The most suitable

Table 12-1

UNIT COST INFORMATION FOR SEWERS IN STABLE GROUND

Pipe Size in.	Cost, Dollars per Lineal Foot for Stated Depths of Dry or Moderately Wet Construction[a]					Imported Backfill[b]	Repaving[c]
	10	15	20	25	30		
12	26.75	31.50	37.50	44.25	51.25	1.28	2.75
15	30.50	36.00	43.00	50.50	58.25	1.35	3.00
18	34.50	41.00	48.50	57.25	66.25	1.45	3.25
21	38.50	45.50	54.25	63.75	73.75	1.55	3.50
24	43.00	50.75	60.25	71.50	82.50	1.70	3.75
30	50.75	59.75	71.50	84.00	97.50	1.85	4.00
36	61.25	71.75	81.25	95.75	111.25	2.00	4.25
42	78.75	91.75	104.75	122.75	141.75	2.10	4.50
48	91.75	107.50	122.25	143.25	165.25	2.25	4.75
54	105.50	123.25	140.25	164.75	190.50	2.40	5.00
60	120.50	140.50	159.75	187.25	216.75	2.55	5.75
66	136.50	156.75	178.25	209.50	241.50	2.75	6.00
72		176.25	200.50	235.20	271.50	2.95	6.25
78		196.75	223.50	262.75	303.50	3.10	6.50
84		217.25	247.00	290.25	335.00	3.25	6.75
90		240.50	273.50	323.75	370.00	3.40	7.00
96		265.00	296.25	354.00	407.75	3.55	7.25
102		290.00	330.25	387.25	446.75	3.70	7.50
108		310.00	360.00	423.25	488.00	3.90	8.00
114		342.25	389.50	457.50	527.50	4.05	8.75
120		371.75	433.00	495.50	572.25	4.20	9.25
132		412.00	469.00	551.75	635.25	4.50	9.75
144			515.50	607.00	699.25	4.85	10.50

[a] Costs are based on an ENR construction cost index of 2100 and the use of reinforced concrete pipe. Costs include pipe, excavation, backfill, laying and jointing, manholes, testing, clean-up and contractors' overhead and profit. Basic costs provide for bedding and initial backfill of select imported granular material to top of pipe and subsequent backfill of native material. Cost of sheeting is included for trench depths greater than 12 ft. For very wet conditions add $10.00 per lineal ft. plus $1.00 per lineal ft. of depth over 10 ft. Costs do not include allowances for construction contingencies, engineering, or right-of-way acquisition.

[b] Imported backfill, add dollars per lineal foot per foot of depth above top of pipe.

[c] Repaving, interference with utilities, and traffic control, add dollars per lineal ft.

TABLE 12-2

UNIT COST INFORMATION FOR SEWERS IN UNSTABLE GROUND

Pipe Size (Inches)	Cost, Dollars per lineal foot for stated depths				
	10 ft.	15 ft.	20 ft.	25 ft.	30 ft.
12	183.41	216.56	260.93	308.00	358.58
15	177.98	223.13	268.72	317.54	369.08
18	184.45	231.00	278.43	328.65	382.20
21	190.49	239.14	288.05	340.55	396.11
24	196.88	246.75	297.41	351.14	410.03
30	210.35	263.55	317.54	374.76	436.28
36	223.91	282.45	338.63	400.66	463.58
42	228.55	287.70	344.40	408.63	473.29
48	238.79	297.68	362.43	428.66	496.65
54	250.87	312.64	379.66	445.42	570.80
60	263.90	329.96	401.80	475.65	551.25
66		348.08	424.03	503.65	581.18
72		371.70	452.2	535.50	619.76
78		395.59	481.25	569.01	661.24
84		413.18	502.86	595.18	689.85
90		428.93	521.33	617.49	714.53
96		453.60	550.90	649.25	752.85
102		479.33	573.13	682.85	791.70
108		505.84	602.70	718.55	836.33
114		530.25	632.45	753.20	876.75
120		559.13	660.89	791.35	923.48
132		598.50	706.13	844.73	988.05
144			752.13	900.90	1052.63

Note: See Table 12-1 for notes.

layout and material for a specific installation must be determined during final design. Diameters of inverted siphons and force mains were calculated by means of the Hazen-Williams formula, using a coefficient of roughness of 120.

Construction costs for force mains are shown in Table 12-3.

Pumping Stations

Pumping stations are designed to handle peak wet-weather flow from their tributary areas. Hydraulic design capacity of pumping stations is, of course, compatible with the capacity and staging of associated trunks and interceptors. Although pumping units may be installed incrementally as required by growing demand, structures are designed for planned maximum development, or for the capacity of adjacent interceptors.

Pumping units for major stations are centrifugal sewage pumps with variable speed drives to minimize wet-well size and reduce odor problems. The number of pumping units installed is sufficient to pump the design flow with one unit out of service. For pumping heads greater than approximately 130 feet, the standard centrifugal pumps are paired in series. Construction and operation and maintenance costs for pumping stations are shown in Figure 12-3

Wastewater Treatment Plants

Primary considerations in the design of a wastewater treatment plant are the required capacity and degree of treatment. Plant capacity is usually expressed in terms of average dry-weather flow. The proper degree of treatment to be provided is based on analyses of waste strength and capacity of the receiving water system. A plant must be designed with sufficient capacity to handle peak organic as well as peak hydraulic loads and must be planned for enlargement to handle future increases. All plant layouts provide for handling peak wet-weather flows.

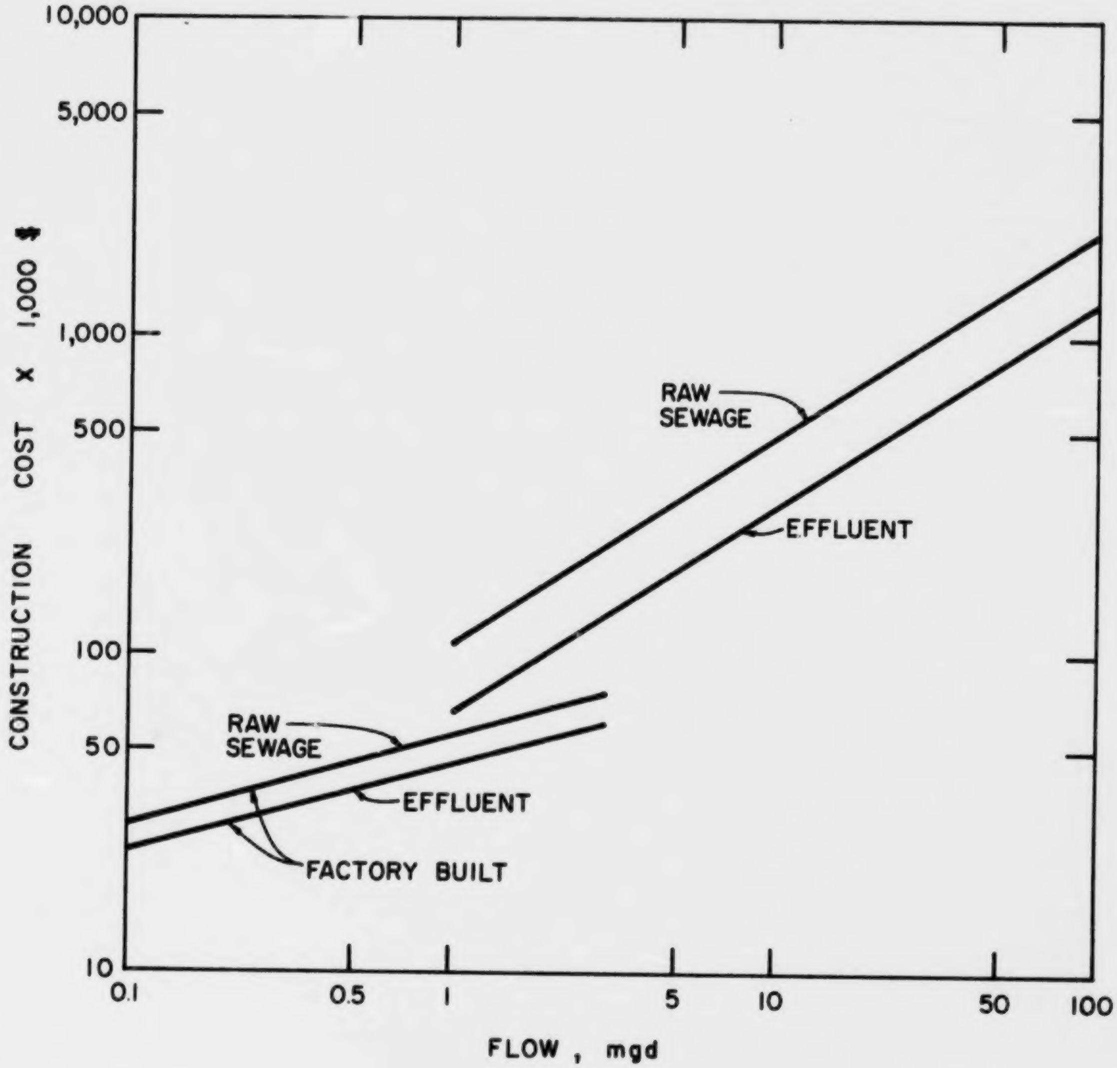
Treatment processes of interest in this study are described in Chapter 11, and design performance levels for various combinations of unit processes are given. Construction and operating costs for the processes used in alternative plans are shown in Figures 12-4 and 12-5. Cost data include costs for solids treatment and disposal processes,

Table 12-3

UNIT COSTS FOR FORCE MAINS

Pipe size inches	Basic Construction Cost, Dollars per Lineal Foot	Imported Backfill, add Dollars per Lineal Foot per Foot of Depth Above Top of Pipe	Repaving, Interference with Uitlities, and Traffic Control, add Dollars per Lineal Foot
12	25.25	1.25	2.75
14	27.50	1.30	2.75
16	30.00	1.35	3.00
18	32.50	1.45	3.25
21	36.25	1.55	3.50
24	40.75	1.70	3.75
27	44.00	1.75	3.75
30	47.75	1.85	4.00
33	52.75	1.95	4.25
36	58.00	2.00	4.25
39	66.25	2.05	4.50
42	74.50	2.10	4.75
45	80.75	2.20	4.75
48	87.25	2.25	5.00
54	100.25	2.40	5.25
60	114.50	2.55	5.75
66	132.50	2.75	6.00
72	149.00	2.95	6.25
78	166.50	3.10	6.50
84	183.75	3.25	6.75
90	203.50	3.40	7.00
96	264.50	3.55	7.25
102	279.25	3.75	7.50
108	304.50	3.90	8.00
114	328.75	4.05	8.75
120	357.00	4.20	9.25
132	406.25	4.50	9.75
144	456.75	4.75	10.50

Costs are based on an ENR construction cost index of 2100 and provided for the use of pressure pipe for operating heads up to 150 ft. Costs include pipe, excavation, laying and jointing, fittings, backfill, testing, clean-up and contractor's overhead and profit. Basic costs provide bedding and initial backfill of select imported granular material and subsequent backfill of native material. Costs are based on pipe laid with four feet of cover in a dry of moderately wet trench. Costs do not include allowance for contingencies, engineering or right-of-way acquisition.



ENR = 2,100
DESIGN CAPACITY, MGD PEAK WET WEATHER FLOW

FIGURE 12-3: ESTIMATED CONSTRUCTION COST OF PUMP STATION

EXPLANATION

1 - CONVENTIONAL PRIMARY
2 - CHEMICAL PRIMARY
3 - SECONDARY BIOLOGICAL
4 - RAPID SAND FILTRATION
5 - CARBON ADSORPTION
6 - PHOSPHATE PRECIPITATION
7 - MICROBIAL DENITRIFICATION

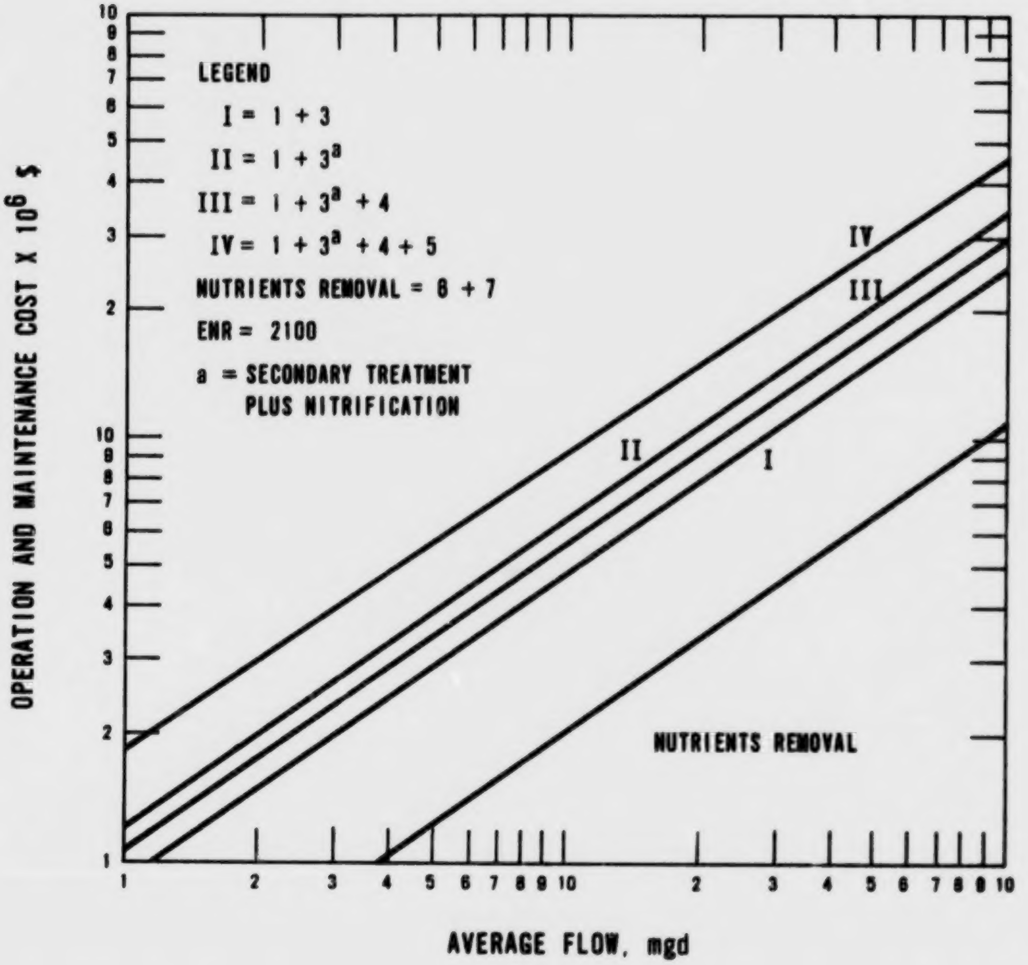


FIGURE 12-4, ESTIMATED CONSTRUCTION COSTS FOR WASTEWATER TREATMENT PROCESS UNITS

EXPLANATION

1 - CONVENTIONAL PRIMARY
2 - CHEMICAL PRIMARY
3 - SECONDARY BIOLOGICAL
4 - RAPID SAND FILTRATION

5 - CARBON ADSORPTION
6 - PHOSPHATE PRECIPITATION
7 - MICROBIAL DENITRIFICATION

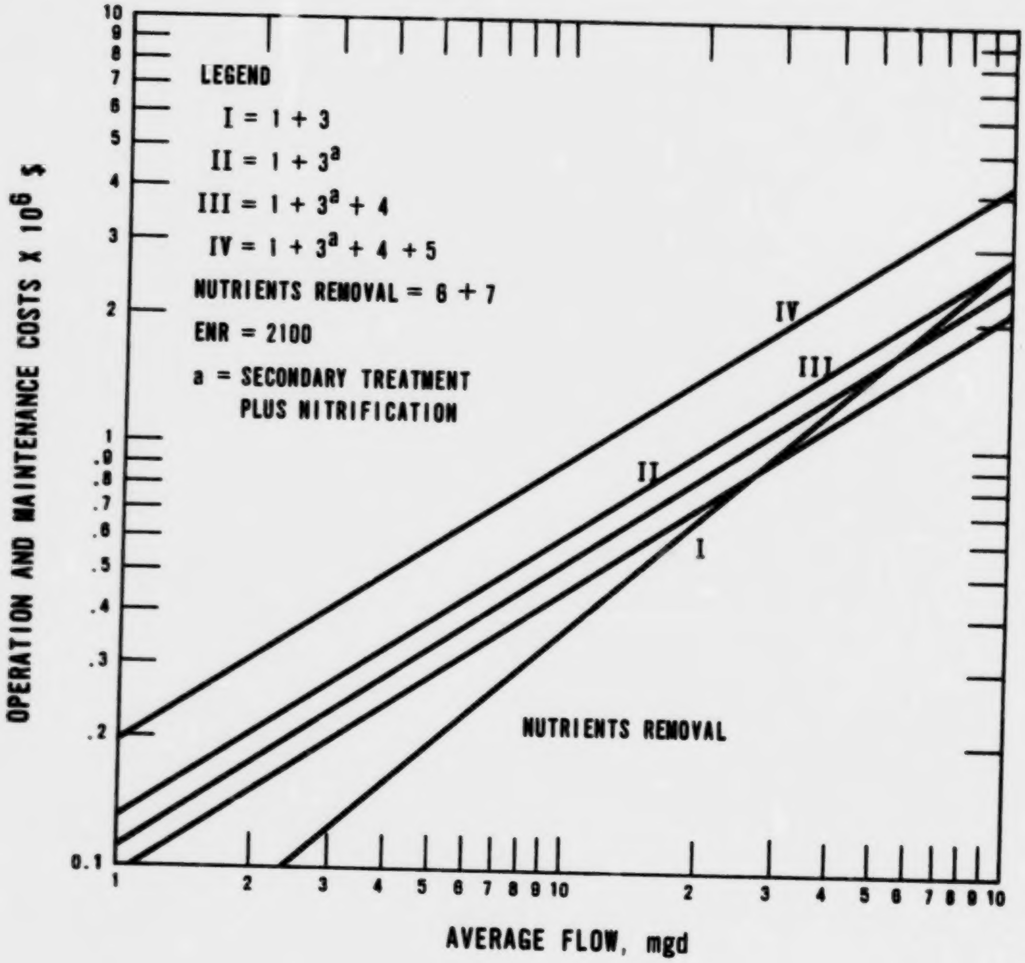


FIGURE 12-5, ESTIMATED ANNUAL OPERATION AND MAINTENANCE COSTS FOR VARIOUS WATEWATER TREATMENT PROCESSES which are necessary adjuncts to the wastewater treatment processes described. Conventional design criteria were used in developing the treatment plant costs.

PROCEDURE FOR EVALUATING NOT-READILY-QUANTIFIABLE FACTORS

This study is a part of a national program, the goal of which is the protection and enhancement of water quality for beneficial uses which include recreation, aesthetics and wildlife propagation. Clearly any evaluation of alternative means of achieving this goal must have as its focus consideration of the environmental costs and benefits associated with the alternatives. These costs and benefits are, however, difficult to quantify and cannot be assigned a dollar value.

A further difficulty is the disparity between the values that different individuals place on environmental quality. To the motorcyclist, enjoyment of the environment requires the provision of bike trails; to the backpacker, engine noise is anathema. The problem is compounded by the inevitable inequality in the distribution of environmental benefits; the definition of a conservationist as a person who has just bought his mountain cabin is not entirely a joke.

Similar uncertainties exist with respect to the importance or value of aspects of an alternative course of action that affect its effectiveness or feasibility.

The procedure adopted for this study involves the identification of environmental elements that may be affected by the proposed plans and assignment of numerical values to the severity of the impact on each environmental element attributable to each alternative plan. In the same way, each alternative is assigned a numerical value that serves as a measure of the alternative's rating with respect to identified effectiveness and feasibility factors. The factors of concern are shown in Figure 12-1, the evaluation matrix.

Each factor within the three major groups of subjective factors is assigned a weight. This weight is a measure of the relative importance of that particular factor compared to other factors within its group only. The relative weights shown in Figure 12-1 were determined by averaging weights assigned by the study advisory board. Thus water quality, with an average weight of ten, was considered more important than recreation, with an average weight of seven, by this sample of opinion. Obviously the relative importance values assigned will be a function of the composition of the weighting group.

The rating of a particular factor, as opposed to the weighting of a factor, is the score an alternative water quality management system receives with respect to that factor. A high rating indicates a "good" score such as would be obtained by a system that has excellent performance, is easily implemented or produces beneficial environmental effects. The converse is true for a low rating.

Each water quality management alternative is rated with respect to each factor on an arbitrary scale of 1 to 10, where 10 represents the best rating and 1 the worst rating. Environmental factors for any alternative are rated on a comparative basis against the existing situation, with "no changes" being represented by a rating of 5, as described in the following section. Feasibility and effectiveness factors for any alternative are rated against an absolute scale, not by comparison with the existing situation. To determine the weighted rating of each factor, its rating for a particular alternative as assigned by the evaluating group is multiplied by its relative weight or importance. To determine the overall score of an alternative with respect to each of the three groups of factors, the weighted ratings of individual factors are summed within each group.

Upon completion of the evaluation procedure, each alternative will have been assigned a rating for each of the three groups of subjective factors. This information, together with the associated costs, provides the public or the group responsible for selection of a course of action with a concise and comprehensive rating of an alternative as an input to the decision-making process. This evaluation process will serve as a coarse screen, reducing the number of promising alternatives to two or three.

EVALUATION OF ENVIRONMENTAL EFFECTS

There is a very complex interrelationship between all forms of life and environment. A water quality management system that initially touches on just one element of the environment may subsequently affect many other elements of the environment and the life forms that the environment supports. Nonetheless, the evaluation procedure attempts to simplify the categorization of reactions to an alternative so that the resulting matrix is of manageable size. Environmental factors included in the evaluation are self-explanatory and include fisheries and aquatic habitats, wildlife and wildlife habitats, water quality, aesthetics and recreation. Figure 12-6 shows a scaling of the effects of alternatives on the various environmental elements. The boundary conditions of man's interaction with a mature ecosystem are represented by preservation in a natural state and complete destruction. In a mature ecosystem the only changes that can be brought about by mankind are to fence it off and leave it untouched or to disturb and degrade it in some manner. For this reason, in calculating ratings for a management alternative, using an absolute scale relative to an undistrubed natural setting would tend to hide any positive effects of altered wastewater management practice. All ratings for environmental parameters were based on a comparison to this existing situation, regardless of the system being used.

EVALUATION OF FEASIBILITY

Evaluation of the feasibility of an alternative water quality management system determines the degree of difficulty involved in implementing the alternative system. Assessments are made of a system's financial feasibility, public acceptability and ease of implementation from a regulatory or institutional standpoint. The feasibility ratings are on an absolute scale and are not intended for comparison with an existing system or a no-system alternative. Figure 12-7 shows an evaluation scale for the feasibility parameters.

Financial Feasibility

Future water quality management systems will involve greater costs, both capital and operating, than have the ongoing programs. As part of the economic evaluation, the total annual cost of each alternative is estimated. An alternative cannot be considered feasible if it imposes an unsupportable financial burden on the agencies responsible for wastewater treatment.

FIGURE 12-6 UTAH LAKE JORDAN RIVER HYDROLOGIC BASIN ENVIRONMENTAL PARAMETER EVALUATION SCALE

SCALE	FISHERIES AND AQUATIC HABITATS	WILDLIFE AND WILDLIFE HABITATS	WATER QUALITY	AESTHETICS	RECREATION	SCALE
10	Significantly improves aquatic habitat and fish productivity	Significantly improves wildlife habitats and wildlife numbers	Significantly improves overall water quality throughout system	Greatly improves aesthetic qualities and provides for future	Greatly increases recreation capacity and provides for future recreation potential	10
9	Improvement in aquatic habitat stability and diversity	Increases wildlife habitat through modification of environment				9
8	Increases aquatic habitat in localized areas		Water quality improved in localized areas	Promotes aesthetic quality in localized areas	Promotes recreation in localized areas	8
7	Changes cause slight improvement but no modification in system	Changes cause slight improvement but no modification in system	Plan causes slight improvement but no modification in system			7
6				Compatible with present aesthetic qualities	Compatible with recreational activities	6
5	No changes reflected within system	No changes reflected within system	No changes reflected within system	No changes in present aesthetic qualities	No effect on recreation	5
4	Changes cause small stresses to system but no modifications	Changes cause small stresses to system but no modifications	Plan causes small stresses to system but no modifications			4
3	Aquatic habitat decreased (i.e., smaller stream flow)			Some loss of areas with desirable aesthetic qualities	Decrease in recreational areas	3
2	Aquatic habitat may become slightly eutrophic; decrease in diversity	Modifies wildlife habitat leading to a degradation/loss of environment	Water quality degraded in localized areas	Degradation of aesthetic qualities in some local areas	Degradation of recreational areas	2
1	Significantly decreases aquatic habitats and reduces fishery productivity	Significantly decreases wildlife habitats and reduces wildlife numbers	Significantly degrades water quality	Totally incompatible with desired aesthetic standards	Totally incompatible with recreational activities	1

FIGURE 12-7 FEASIBILITY / EFFECTIVENESS FACTORS EVALUATION SCALE

	FEASIBILITY			EFFECTIVENESS				
SCALE	FINANCIAL FEASIBILITY	PROGRAM IMPLEMENTATION	PROGRAM ACCEPTABILITY	EFFECTIVENESS	SYSTEM RELIABILITY	SYSTEM FLEXIBILITY	RECLAMATION POTENTIAL	SCALE
10	Well within funding capabilities of area	No institutional changes necessary to implement alternative	Totally compatible with all interests	Alternative completely meets or exceeds established performance criteria	Complete mechanical and process reliability in maintaining performance	System needs minimal alterations to meet changed requirements	System can be readily adapted to reclaim water	10
9			Partially compatible with almost all interests					9
8								8
7		Several institutional changes necessary			System performance slightly better than average			7
6			Compatible with some interests	Alternative meets minimal performance criteria				6
5	Marginally fundable		Minimally compatible with all interests		Average reliability	System needs moderate alterations to meet changed requirements		5
4				Alternative meets minimal performance criteria part of the time				4
3			Incompatible with some interests		System performance slightly better than average			3
2			Partially incompatible with all interests					2
1	Well beyond funding capabilities of area	Requires complete restructuring of responsible institutions	Incompatible to public, government agencies or private interests	Alternative does not adequately meet established performance criteria	Poor system reliability	System needs extensive alterations to meet changed requirements	System totally unsuitable for water reclamation	1

Program Acceptability

The disposal system and its financing should be acceptable to the public, government agencies and private interests. Opposition by local societies or groups, or irrational but widespread unpopularity of an alternative, can affect the feasibility of a system.

Program Implementation

Program implementation is a measure of the facility with which agencies can reorganize or legislative changes can be made in order to effect a water quality management alternative. This factor does not measure the desirability of a change or reorganization but the degree of difficulty expected in achieving it. The choices range from systems that are extremely difficult to implement, requiring major State legislative changes and major agency rearrangements, to systems readily compatible with existing laws and agency jurisdictions.

EFFECTIVENESS

The purpose of this part of the evaluation procedure is to determine how effective and reliable alternative systems would be in meeting performance criteria. The ratings for each alternative are determined against absolute standards of performance and not against relative performance of other alternatives. Figure 12-7 shows the scales used in evaluating effectiveness.

System Effectiveness

Will an alternative meet or exceed, and if so to what degree, the performance criteria established earlier? What is the relationship between total cost and expected performance for each alternative?

System Reliability

The reliability of treatment plant performance varies, depending upon the processes employed. Advanced treatment processes such as carbon adsorption have an inherently lower reliability than conventional treatment processes. What mechanical or process failures may occur, and what will be the severity of their consequences?

System Flexibility

Will an alternative system readily accommodate unforeseen demographic events? Can a system be adapted to meet changing water quality requirements?

Reclamation Potential

Although there may be no present market for reclaimed water in the Utah Lake-Jordan River area, alternative systems that retain the option to convert to water reclamation in the future clearly offer some advantages. Does an alternative system facilitate future water reclamation?

THE EVALUATION PROCESS

Water quality problems may be solved in countless different ways; however, only a few of these alternative solutions may be applicable to particular cases. To avoid unproductive work it is necessary to develop a systematic reasoning process that will allow the identification of a broad range of candidate courses of action, elimination of unpromising alternatives and evaluation of a number of promising alternatives. The flow chart shown in Figure 12-1 is a graphical representation of the process used in this study.

PUBLIC PARTICIPATION AND THE EVALUATION PROCESS

The Federal Water Pollution Control Act requires that the public participate in the selection of a water quality management system. Every effort was made during the planning study to comply with this provision by holding both public meetings and meetings with special interest groups.

One difficulty was encountered: despite media advertisement of public meetings, few uncommitted members of the public could be persuaded to attend. Attendance at the meetings was made up of individuals who were already involved in some way with water quality management--city officials, consulting engineers and wastewater treatment plant personnel.

On completion of the first year of the study, principally concerned with problem definition, a report was prepared and widely distributed in the study area. Public meetings were held in each county to discuss the first year results in the Fall of 1973. At these same meetings the procedure for evaluating the alternatives, described in this chapter, was presented to the public. Comments on the evaluation factors and their weightings were solicited and incorporated into the evaluation procedure.

In the first week of January 1974 alternative courses of action for municipal wastewater management were presented to the public in each county. Costs and ratings with respect to not-readily-quantifiable factors were included in the presentation. During the following three months the staffs of the Division of Health and the consultants met with many of the sewerage agencies, cities, councils of government and local engineers to discuss and refine the alternatives and to move toward a mutually acceptable recommended plan.

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CHAPTER 13

WATER QUALITY MANAGEMENT ALTERNATIVES

The purpose of the water quality management study is to develop a comprehensive plan that, when implemented, will improve water quality within the basins to a level that will maximize the benefits to be gained from the resources. To accomplish this objective, it has been necessary to consider all of man's activities as they may affect water quality.

It is apparent from the preceding analysis of water quality in the study area that water pollution results from a multitude of sources, and consequently abatement of a single pollution source, municipal sewage for example, cannot be expected to completely solve the problem. Clearly an ideal approach to selection of a water quality management plan would include development of environmental benefit-cost functions for each waste source and selection of the most cost-effective overall control strategy. Unfortunately these functions are extremely difficult to develop, particularly with respect to non-point waste sources. What would be the benefits to water quality of doubling the investment in street-cleaning and thus reducing the pollution potential of urban runoff? It is very difficult to provide numerical answers to questions of this sort.

The estimation of basin-wide waste loads from various sources does, however, allow a determination to be made of the relative importance of the sources. With respect to oxygen-demanding material, municipal wastewater is the most significant source, followed by urban runoff. Agricultural and industrial activities are the most potent sources of salts.

A second factor that must be considered in devising water quality management strategies is the relative controllability of the different waste sources. Non-point sources of pollutants are inherently more difficult to control than point sources. This has led to a legislative emphasis on the control of point sources and financial assistance to publicly owned wastewater treatment facilities, which in turn influences the development of water quality management strategies.

Because of this emphasis on point sources of pollution and because of the dominant role municipal wastewaters play in depleting the dissolved oxygen content of stream waters, the development of alternatives will focus on control of point sources. General approaches to abatement of non-point source pollution are recommended in the following chapter.

CONTROL OF POINT SOURCES OF INDUSTRIAL WASTE

Discrete discharges of industrial wastewaters must meet Utah's interim effluent requirements and the effluent requirements of the Federal Water Pollution Control Act as amended in 1972. Wastewaters must receive best practicable treatment by 1977 and best available treatment by 1983. Industrial wastewaters discharged to municipal sewerage systems must contain only compatible pollutants, those that do not adversely affect the municipal wastewater treatment system. Other pollutants must be removed to a degree that represents the results of the application of best practicable and best available control technology.

Industries will seek to comply with these requirements in a way that is in their own best interests. Evaluation and selection of an appropriate course of action will be undertaken by the industries themselves. It is not a part of a study of this nature to analyze industries' options.

There are two circumstances under which control of industrial wastes becomes important to this study: where benefits accrue to the community if industrial and municipal wastes are treated jointly and where compliance with the requirements of the Federal Water Pollution Control Act does not lead to compliance with water quality standards.

The former situation can occur when a large industrial discharger is located close to a small municipality. There appear to be no cases in the study area where benefits might be derived from joint treatment under these circumstances with the exception of the presently used joint facilities at Copperton. In the North Salt Lake County-South Davis County area there is a concentration of industry, some of which discharges waste to municipal sewer systems while the reaminder is treated and discharged directly to the surface waters. It is possible that as effluent requirements become more stringent some industries may find that it is less expensive to contract with a municipality for treatment rather than retaining a discrete waste stream. If an industry elects to discharge waste to a municipal system, it is a legal requirement that the industry pay an equitable share of the treatment costs.

Some cases exist where compliance with the provisions of the Federal Water Pollution Control Act or the State of Utah's interim effluent standards may not lead to compliance with all of the 1983 Class "C" water quality standards. These cases were discussed in the section of Chapter 11 dealing with waste load allocations.

DEVELOPMENT OF MUNICIPAL WASTEWATER MANAGEMENT ALTERNATIVES

Discharges of wastewater from publicly owned treatment works must receive secondary treatment by 1977 and best practicable treatment by 1983. Utah's interim effluent standards will require a 10 mg/l BOD and 10 mg/l suspended solids effluent by 1980. Meeting these requirements will necessitate increased expenditure of funds on wastewater management facilities. The use of advanced wastewater treatment processes results in both capital and operation and maintenance costs considerably in excess of the cost associated with conventional treatment. Substantial scale economics exist with respect to wastewater treatment processes. Thus, regionalization or consolidation of treatment facilities may offer financially attractive wastewater management alternatives.

Several other advantages of large wastewater treatment facilities are apparent. A reduced peak factor and the more predictable growth rate of a larger tributary population allow the design flow rate of a large plant to be somewhat less than the sum of the design flows of several small plants serving the same population. Large plants, with more numerous and better qualified staff, can produce effluent of high quality more consistently than can small plants.

The study area was divided into sub-areas and municipal wastewater management alternatives were developed for each area. Sub-areas often follow county boundaries; this is a result of demographic factors rather than a recognition of administrative boundaries.

The alternatives include varying degrees of wastewater treatment consolidation, different levels of treatment and relocation of discharge points, as discussed in Chapter II. The minimum treatment requirement in 1980 will be level III. This level of treatment may still prove insufficient to meet stream water quality standards in some cases. Hence, alternatives are considered that include a higher level of treatment; level IV treatment.

Reclamation and Reuse Options

Although the study area is located in an arid region, water resources have been, and are being, developed to meet the water needs of agriculture, industry and the cities. Large quantities of Colorado River water are to be diverted into the basins as part of the Central Utah Project. In view of the availability of water from other sources, reclamation and reuse of wastewaters cannot generally be justified on economic grounds at this time. It is true, however, that circumstances may change during the lives of the facilities proposed in this report. Development of Eastern Utah's coal and oil shale reserves would necessarily increase the demand for Colorado River water. Thus, while immediate wastewater reclamation has not been included as an alternative course of action, many of the alternatives retain reuse, particularly for landscape irrigation or industrial cooling purposes, as an option for the future.

Land Disposal Options

Land disposal of wastewaters does not seem to be an attractive option in the study area for several reasons.

In Davis and Utah Counties and in the northern part of Salt Lake County, many of the existing treatment plants are located close to the Great Salt Lake and Utah Lake. High-water tables in these areas would make land disposal ineffective. In the Salt Lake Valley, the existing treatment plants are located close to human habitation. Only in sparsely populated Wasatch does land disposal appear to be a marginally feasible option.

Another serious problem with land disposal in the study area is the long period of frost which would make it technically difficult and ineffective in preventing stream pollution, if the wastewater were continuously applied to the land.

Land area for wastewater disposal is available to the west of Utah Lake in the Goshen, Elberta and Cedar Valley areas and in the Tooele and Grantsville areas west of Salt Lake City. The long pipelines and numerous pumping stations required to implement these alternatives make them economically unattractive particularly if a Class D water must be achieved prior to usage. These alternatives would become increasingly promising as the following conditions were achieved: (1) Control of water rights by the sewerage entity and sale of the water, (2) Use of the irrigated acreage as a treatment system with only minimal initial treatment of the sewage before irrigation, (3) Development of large detention ponds to store the valuable water during the non-irrigatiog season. These ponds would have to be designed as treatment lagoons since they would, in fact, operate as such.

A case by case evaluation of land disposal during facility planning would be in order but as mentioned above, this option does not seem economically competitive for the area. .

MUNICIPAL WASTEWATER MANAGEMENT ALTERNATIVES FOR DAVIS COUNTY

Municipal wastewaters generated within Davis County are collected and conveyed westward to four treatment plants located on the flatlands bordering the Great Salt Lake and Farmington Bay. Present and projected wastewater flows to these plants are shown in Table 13-1. Wast load allocations and required treatment levels are shown in Table 13-2.

Alternative Courses of Action

The most promising alternatives for Davis County are described on the following pages and illustrated in Figure 13-1.

Table 13-1

PRESENT AND PROJECTED WASTEWATER FLOWS[a]

DAVIS COUNTY

Source	1972	1980	1995
North Davis	10.4	17.0	22.4
Central Davis	1.8	3.6	5.9
South Davis North	4.2	5.6	7.8
South Davis South	1.4	1.8	2.3

[a] Assuming elimination of excessive infiltration and inflow to the collection system.

Table 13-2

MUNICIPAL WASTE LOAD ALLOCATIONS AND TREATMENT LEVELS[a]

DAVIS COUNTY

Source	Effluent Quality BOD, mg/1	Waste Load Alloc. BOD, lbs/day	Required Treatment Level	Probability of Compliance with W.Q. Standards
North Davis	10	1,418	III	Good
Central Davis	10	300	III	Good
South Davis North	10	416	III	Fair
South Davis South	10	150	III	Poor

[a] Assessment of the probability that application of the required treatment level will result in compliance with water quality standards in the receiving waters.

Alternative 1	Modify and expand existing treatment plants at existing locations. Level IV treatment at all plants.
Alternative 2	As Alternative 1, but level III treatment at all plants.
Alternative 3	Modify and expand existing treatment plants at existing locations. Construct lake outfalls at North and Central Davis. Level III treatment at North and Central Davis; level IV treatment at South Davis North and South.
Alternative 4	As Alternative 3, but level III treatment at South Davis North and South.
Alternative 5	Modify and expand North Davis and South Davis North and South plants. Abandon Central Davis, convey flows to North Davis. Construct lake outfall at North Davis. Treatment level III at North Davis; treatment level IV at South Davis North and South.
Alternative 6	Same as Alternative 5, but level III treatment at South Davis North and South.
Alternative 7	Modify and expand North, Central, and South Davis North. Abandon South Davis South, convey flows to South Davis North. Construct lake outfalls at North and Central Davis. Treatment level III at North and Central Davis. Treatment level IV at South Davis North.
Alternative 8	Same as Alternative 7, but level III treatment at South Davis North.
Alternative 9	Modify and expand North and Central Davis. Construct lake outfalls at North and Central Davis. Level III treatment. Abandon South Davis South and South Davis North. Convey flows to Central Davis.
Alternative 10	Modify and expand North and Central Davis. Construct lake outfalls at North and Central Davis. Level III treatment. Level IV treatment at South Davis North. Abandon South Davis South. Convey flows to Salt Lake City. Treatment level IV.
Alternative 11	Same as Alternative 10, but level III treatment at South Davis North and Salt Lake City.
Alternative 12	Modify and expand North and Central Davis. Construct lake outfalls at North and Central Davis. Level III

treatment. Abandon South Davis North and South Davis South. Convey flows to Salt Lake City. Treatment level IV.

Alternative 13 Same as Alternative 12, but level III treatment at Salt Lake City.

Evaluation of Alternatives

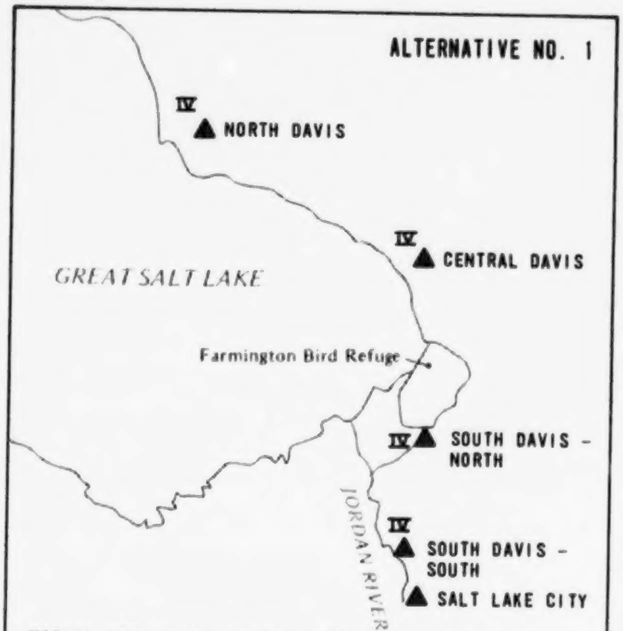
Each alternative was evaluated by the study consultants as described in Chapter 12. The results of the evaluation are summarized in Table 13-3. Detailed evaluation matrixes are included in Appendix 13-A. This material was included in a briefing document describing alternative courses of action for treatment and disposal of municipal wastewaters and their costs. The document was mailed to concerned individuals and agencies in December 1973. A public meeting to discuss the alternatives was held in Davis County in January 1974. Local opinion did not appear to favor any particular alternative, although some reluctance to alter present arrangements for sewage collection, treatment, and disposal was expressed.

A meeting was held on 2 April between the State Division of Health, their consultants and technical representatives of the three sewage agencies. Projected flows, estimated costs and possible courses of action were discussed. While no strong concensus was reached, much information and informed opinion emerged which has influenced the formulation of the recommended plan.

Analysis of Alternatives

A review of the alternatives indicates that the least total annual cost of meeting the interim standards is incurred by upgrading the four treatment plants at their present locations, with the possible option of combining the two South Davis plants. If it is necessary to upgrade the plants still further in order to meet the Class "C" stream standards, it is apparent that some degree of regionalization becomes attractive. Alternatives 5, 7, 9, 10, and 12 incur total annual costs within 12 percent of each other, while the no-outfall, no-regionalization option costs approximately 25 percent more at level IV treatment. In view of the preliminary nature of the cost estimates, the cost of the six alternatives can be considered to be approximately equal. Of this group of alternatives, 10 and 12 are somewhat unattractive since they involve a difficult to implement cross-county-line conveyance of sewage. Thus, with respect to the ultimate goal, regionalization

ALTERNATIVE NO. 1


IV
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IV
CENTRAL DAVIS
GREAT SALT LAKE
Farmington Bird Refuge
IV
SOUTH DAVIS - NORTH
JORDAN RIVER
IV
SOUTH DAVIS - SOUTH
SALT LAKE CITY

MODIFY AND EXPAND EXISTING TREATMENT PLANTS AT EXISTING LOCATIONS. LEVEL IV TREATMENT AT ALL PLANTS.

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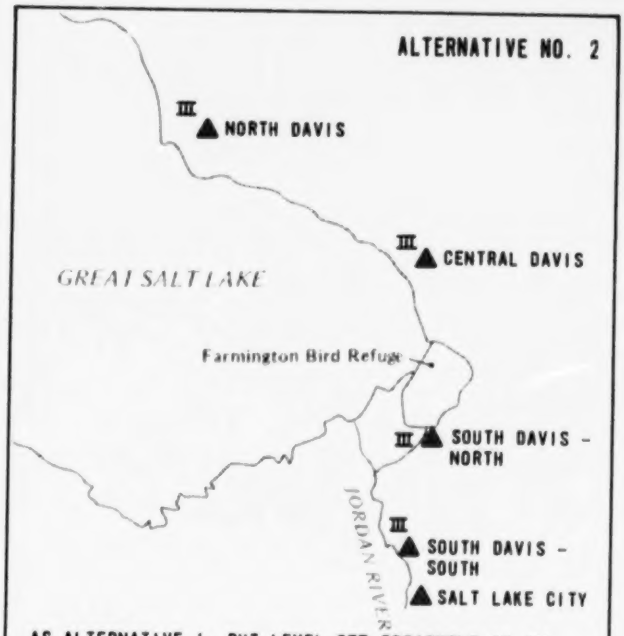
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AS ALTERNATIVE 1, BUT LEVEL III TREATMENT AT ALL PLANTS

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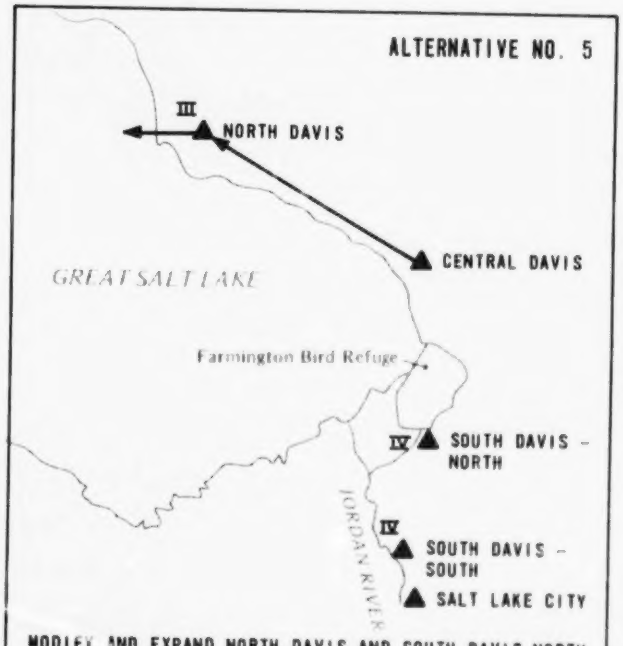
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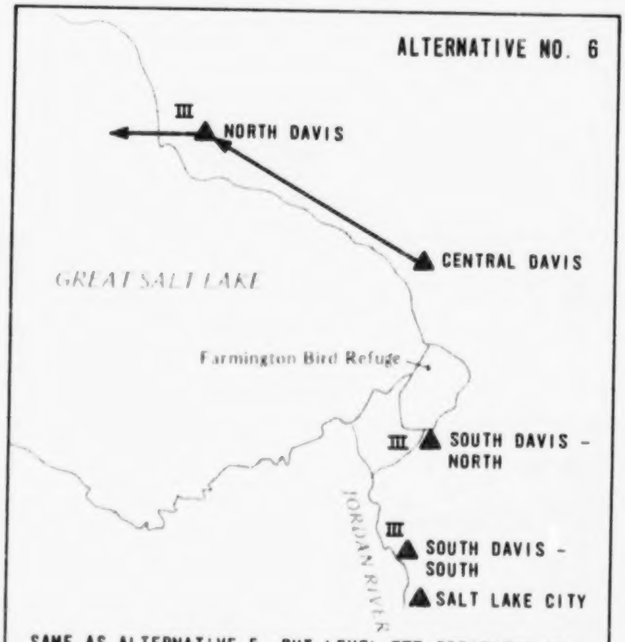
SALT LAKE CITY

MODIFY AND EXPAND NORTH DAVIS AND SOUTH DAVIS NORTH AND SOUTH PLANTS. ABANDON CENTRAL DAVIS, CONVEY FLOWS TO NORTH DAVIS. CONSTRUCT LAKE OUTFALL AT NORTH DAVIS. TREATMENT LEVEL III AT NORTH DAVIS; TREATMENT LEVEL IV AT SOUTH DAVIS NORTH AND SOUTH.

ALTERNATIVE NO. 6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JORDAN RIVER
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SALT LAKE CITY

SAME AS ALTERNATIVE 5, BUT LEVEL III TREATMENT AT SOUTH DAVIS NORTH AND SOUTH.

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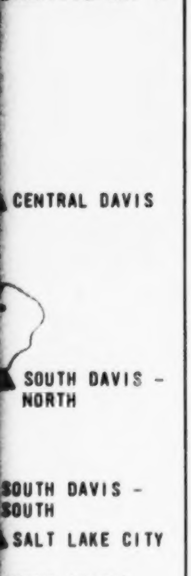
ERNATIVE NO. 2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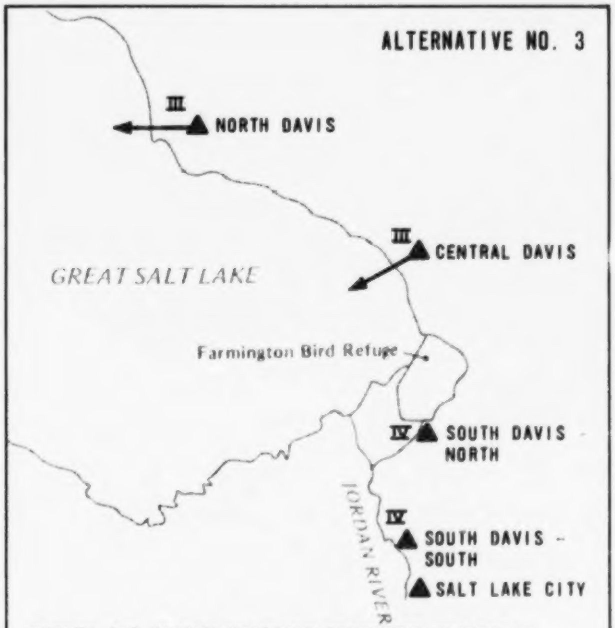
ALTERNATIVE NO. 3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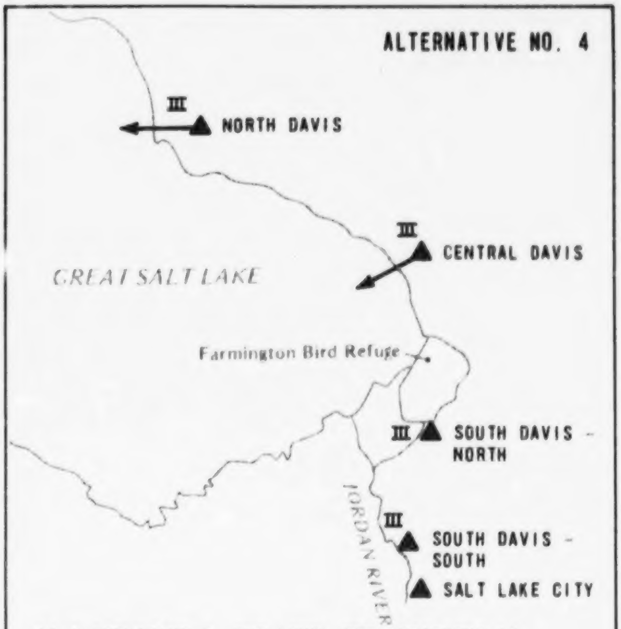
SALT LAKE CITY

MODIFY AND EXPAND EXISTING TREATMENT PLANTS AT EXISTING LOCATIONS. CONSTRUCT LAKE OUTFALLS AT NORTH AND CENTRAL DAVIS. LEVEL III TREATMENT AT NORTH AND CENTRAL DAVIS; LEVEL IV TREATMENT AT SOUTH DAVIS NORTH AND SOUTH.

ALTERNATIVE NO. 4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SALT LAKE CITY

AS ALTERNATIVE 3, BUT LEVEL III TREATMENT AT SOUTH DAVIS NORTH AND SOUTH.

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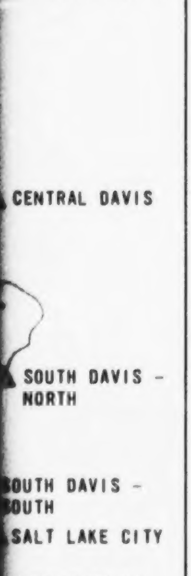
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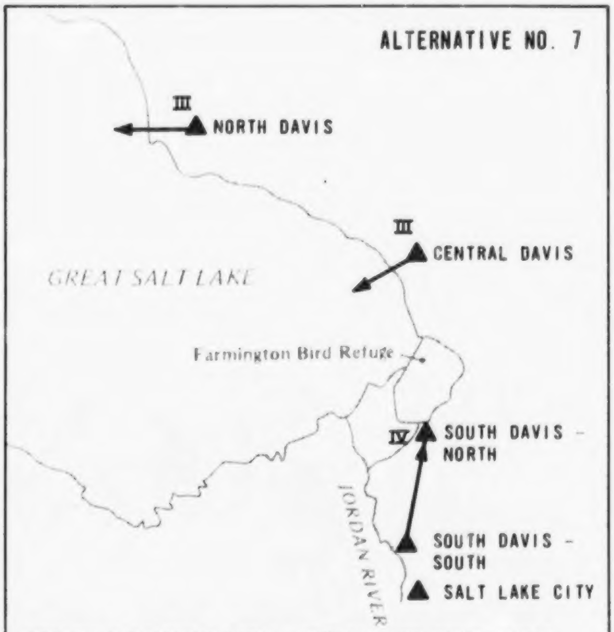
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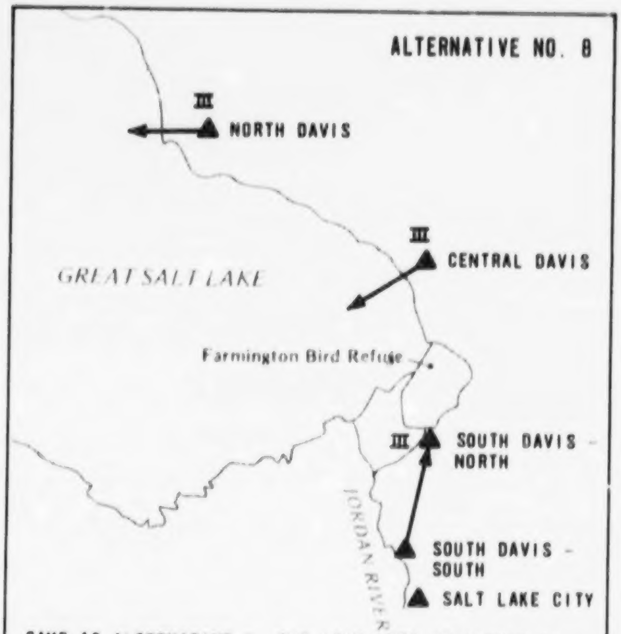
SALT LAKE CITY

MODIFY AND EXPAND NORTH, CENTRAL AND SOUTH DAVIS NORTH. ABANDON SOUTH DAVIS SOUTH, CONVEY FLOWS TO SOUTH DAVIS NORTH. CONSTRUCT LAKE OUTFALLS AT NORTH AND CENTRAL DAVIS. TREATMENT LEVEL III AT NORTH AND CENTRAL DAVIS. TREATMENT LEVEL IV AT SOUTH DAVIS NORTH.

FIGURE 13-1
DAVIS COUNTY
MUNICIPAL WASTEWATER
MANAGEMENT ALTERNATIVES

B -13-9

ALTERNATIVE NO. 8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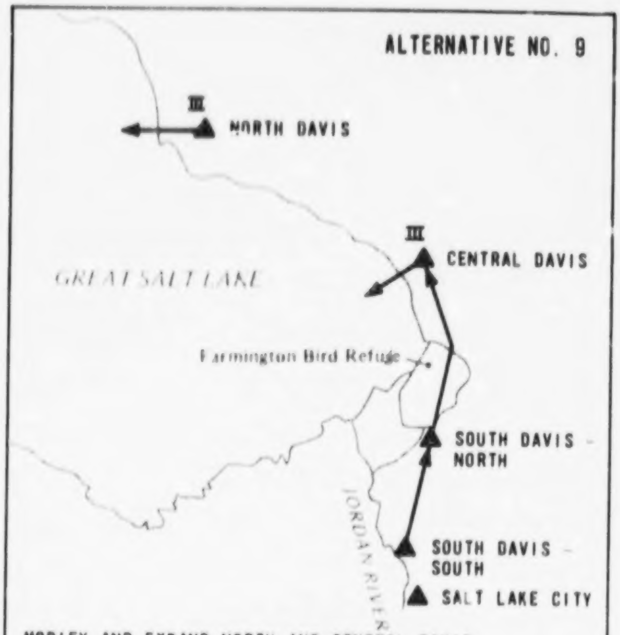
SAME AS ALTERNATIVE 7, BUT LEVEL III TREATMENT AT SOUTH DAVIS NORTH.

ALTERNATIVE NO. 9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MODIFY AND EXPAND NORTH AND CENTRAL DAVIS. CONSTRUCT LAKE OUTFALLS AT NORTH AND CENTRAL DAVIS. LEVEL III TREATMENT. ABANDON SOUTH DAVIS SOUTH AND SOUTH DAVIS NORTH. CONVEY FLOWS TO CENTRAL DAVIS.

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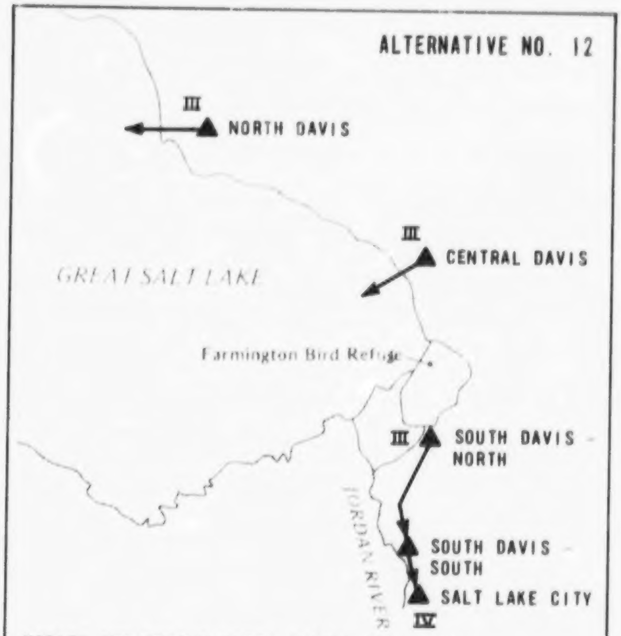
ALTERNATIVE NO. 12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MODIFY AND EXPAND NORTH AND CENTRAL DAVIS. CONSTRUCT LAKE OUTFALLS AT NORTH AND CENTRAL DAVIS LEVEL III TREATMENT. ABANDON SOUTH DAVIS NORTH AND SOUTH DAVIS SOUTH. CONVEY FLOWS TO SALT LAKE CITY TREATMENT LEVEL IV.

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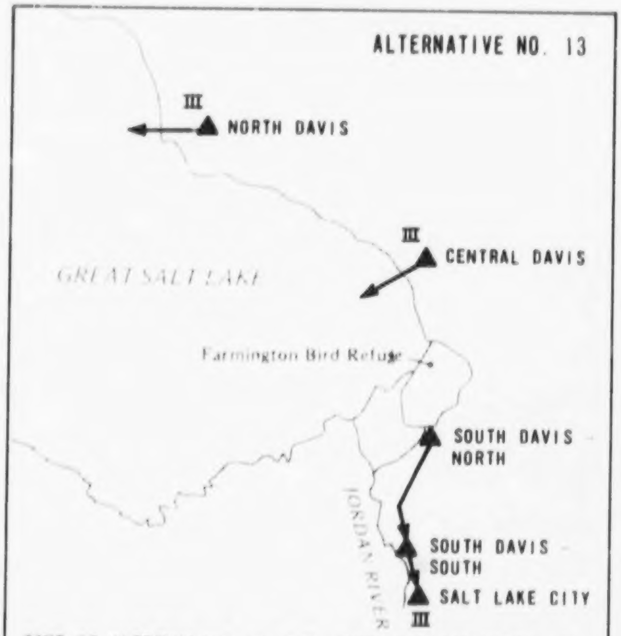
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SAME AS ALTERNATIVE 12, BUT LEVEL III TREATMENT AT SALT LAKE CITY.

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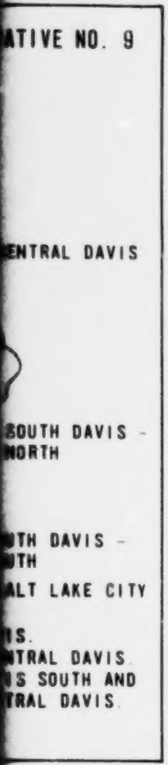
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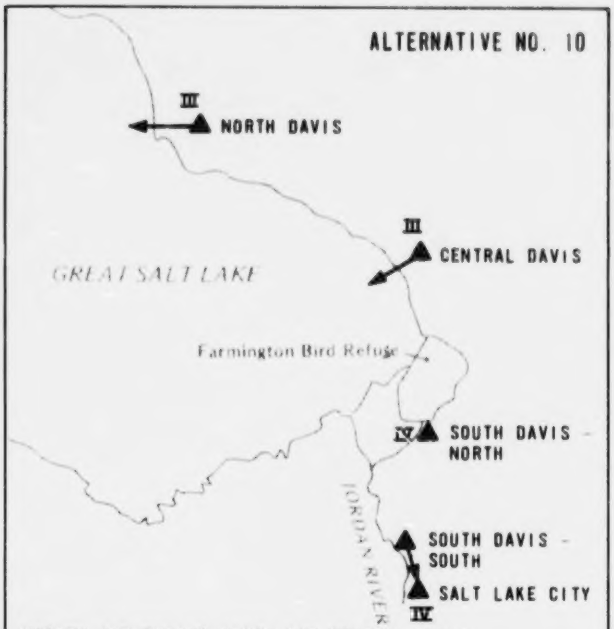
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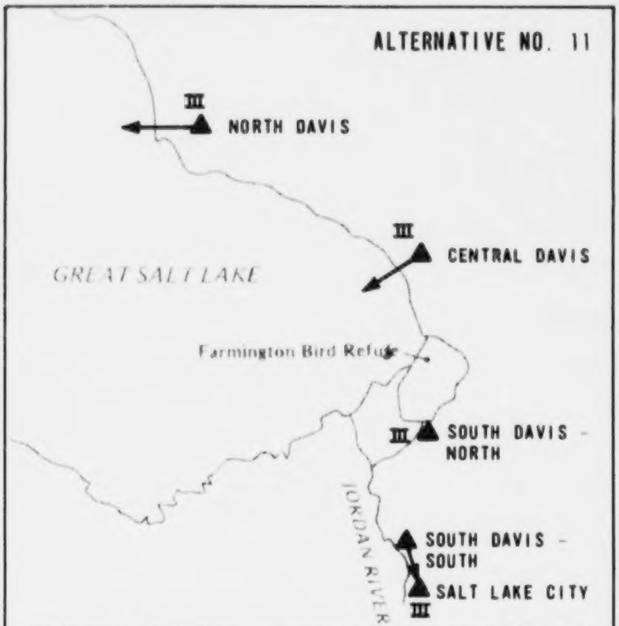
SOUTH DAVIS - SOUTH
SALT LAKE CITY
IV

MODIFY AND EXPAND NORTH AND CENTRAL DAVIS. CONSTRUCT LAKE OUTFALLS AT NORTH AND CENTRAL DAVIS. LEVEL III TREATMENT. LEVEL IV TREATMENT AT SOUTH DAVIS NORTH. ABANDON SOUTH DAVIS SOUTH. CONVEY FLOWS TO SALT LAKE CITY. TREATMENT LEVEL IV.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Farmington Bird Refuge
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JORDAN RIVER
SOUTH DAVIS - SOUTH
SALT LAKE CITY
III

SAME AS ALTERNATIVE 10, BUT LEVEL III TREATMENT AT SOUTH DAVIS NORTH AND SALT LAKE CITY.

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FIGURE 13-1 (Continued)
DAVIS COUNTY
MUNICIPAL WASTEWATER
MANAGEMENT ALTERNATIVES

B-13-10

Table 13-3

DAVIS COUNTY - SUMMARY OF EVALUATION OF ALTERNATIVES[a]

Alternative	1	2	3	4	5	6	7	8	9	10	11	12	13
Treatment Level	IV	III	III&IV	III	III&IV	III	III&IV	III	III	III	III	IV	III
Capital Cost	19.28	6.62	16.81	12.52	18.86	14.58	19.73	16.10	22.13	18.31	14.84	22.18	20.88
Annual Amortization Cost	1.53	0.52	1.30	1.01	1.51	1.17	1.50	1.21	1.64	1.39	1.11	1.67	1.58
Annual Operation and Maintenance Cost	3.30	2.20	2.59	2.21	2.36	1.98	2.44	2.14	1.93	2.36	2.06	2.17	2.07
Total Annual Cost	4.83	2.73	3.89	3.22	3.87	3.15	3.94	3.35	3.58	3.75	3.17	3.84	3.65
Subjective Ratings													
Environmental	259	218	252	226	261	226	275	242	280	275	249	287	287
Feasibility	208	236	200	210	182	183	182	174	147	182	183	163	155
Effectiveness	120	125	147	137	160	144	182	182	217	189	180	212	197

[a] All costs are expressed in millions of dollars.

Table 13-4

DAVIS COUNTY - EFFECT OF REDUCED OPERATION AND MAINTENANCE COSTS[a]

Alternative	1	2	3	4	5	6	7	8	9	10	11	12	13
Adjusted Annual Operation and Maintenance Cost	1.10	0.73	0.86	0.74	0.79	0.66	0.81	0.71	0.64	0.78	0.69	0.72	0.69
Adjusted Total Annual Cost	2.63	1.26	2.17	1.75	2.29	1.83	2.31	1.93	2.29	2.17	1.80	2.40	2.27

[a] All costs expressed in millions of dollars.

Alternatives 5, 7 and 9 and the similarly priced Alternative 3--no regionalization but outfalls at North and Central Davis--appear to be the most attractive options. Alternative 9 offers some advantages with respect to environmental factors and effectiveness since discharges are eliminated from the lower Jordan River; however, disadvantages of this alternative are its high capital cost and its low level of acceptability of the sewerage agencies. Of the remaining three alternatives, Alternative 7 is the best with respect to environmental factors and effectiveness and is fairly easy to implement.

One item of concern to treatment facility personnel and their engineers was the estimates of operation and maintenance cost used in the evaluation of alternatives, which they felt were too high for Utah conditions. In response to this concern, the total annual cost of the alternatives was recalculated with operation and maintenance costs arbitrarily reduced by two-thirds.

A review of Table 13-4 indicates that in this case, total annual cost of Alternative 1--no regionalization, no outfalls, level IV treatment--becomes comparable with the cost of Alternatives 3, 5, 7 and 9. Other considerations, with respect to environmental and effectiveness factors, lead to the conclusion that since the costs are approximately the same, Alternative 7 is still the best option.

MUNICIPAL WASTEWATER MANAGEMENT ALTERNATIVES FOR SALT LAKE COUNTY

For the purposes of this analysis, Salt Lake County has been divided into three areas: the Salt Lake Valley, West Salt Lake County, and the Canyonlands. The Salt Lake Valley contains by far the greater part of the basin population and most of the existing wastewater treatment facilities. West Salt Lake County includes the communities of Magna, Copperton, and Lark, while the Canyonlands include the western slopes and canyons of the Wasatch Front.

Present and projected wastewater flows are shown in Table 13-5. Waste load allocations are shown in Table 13-6.

At the present time, approximately one-half of the wastewaters generated in the Salt Lake Valley are tributary to the Salt Lake City Treatment

Plant and are discharged after treatment to the Salt Lake City Sewage Canal which flows to the Great Salt Lake. The remaining half is treated at seven waste treatment facilities and discharged to a 14-mile reach of the Jordan River between 94th and 21st South. By 1995 the proportion of waste generated that will be discharged to this reach of the river will have risen to 63 percent and will have more than doubled in volume.

Prior to consideration of alternative wastewater management systems for the Salt Lake Valley one critical point must be made. A course of action that is less an alternative than an imperative, if the Jordan River is to support a balanced aquatic flora and fauna, is that a minimum acceptable flow must be maintained in the Jordan River at all times, irrespective of existing water rights. Unless this can be attained, other measures that modify the quality of the waste discharges are unlikely to enhance wildlife propagation. A minimum acceptable flow rate in the Jordan River may be determined using the water quality model. A first-cut estimate of minimum flow rate is shown in Table 11-6.

TABLE 13-5

Present and Projected Wastewater Flows-Salt Lake County[a]

Source	1972	1980	1995
Sandy City	1.7	2.8	4.0
Tri-Community	3.8	9.9	15.3
Murray City	2.4	3.4	4.6
Salt Lake County-Cottonwood	5.3	7.9	13.0
Granger-Hunter I.D.	6.1	9.2	14.2
Salt Lake City SSD #1	11.7	13.7	16.7
South Salt Lake City	3.7	5.4	7.8
Salt Lake City	33.4	37.9	43.5

[a] Assuming elimination of excessive infiltration and inflow to the collection system.

Alternative Courses of Action--Salt Lake Valley

The most promising alternatives for municipal wastewater management are described below and illustrated in Figure 13-2.

Alternative	1	Modify and expand all existing plants at existing locations to level IV.
Alternative	2	Same as 1, but level III treatment.
Alternative	3	Abandon Sandy, Murray, Granger-Hunter, and South Salt Lake

Table 13-6

MUNICIPAL WASTE LOAD ALLOCATIONS AND TREATMENT LEVELS[a]

SALT LAKE COUNTY

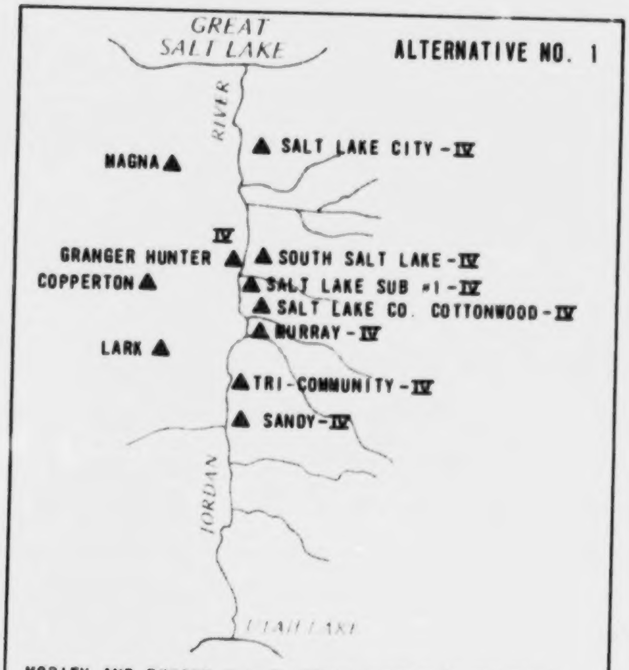
Source	Effluent Quality BOD, mg/1	Waste Load Alloc. BOD, lb/day	Required Treatment Level	Probability of Compliance with W.Q. Standards
Sandy City	10	234	III	Fair
Tri-Community	10	827	III	Fair
Murray City	10	284	III	Poor
Salt Lake County, Cottonwood	10	660	III	Poor
Granger-Hunter I.D.	10	768	III	Poor
Salt Lake City SSD #1	10	1,142	III	Poor
South Salt Lake City	10	451	III	Poor
Salt Lake City	10	3,160	III	Poor

[a] Assessment of the probability that application of the required treatment level will result in water quality standard compliance in the receiving waters.

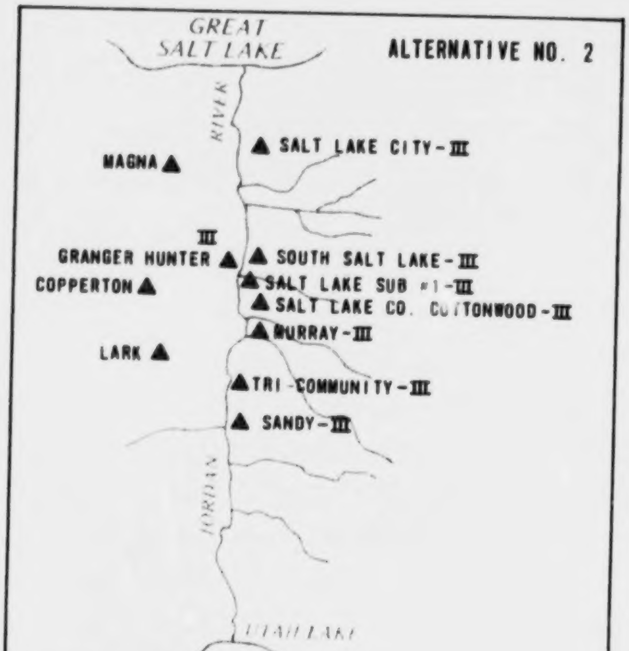
	plants. Convey flows from Sandy to Tri-Community, Murray to Cottonwood and from Granger-Hunter and South Salt Lake to Salt Lake City Suburban No. 1. Modify and expand Tri-Community, Cottonwood, Salt Lake City Suburban No. 1 and Salt Lake City plants. Treatment level IV.
Alternative 4	Same as 3, but level III treatment.
Alternative 5	Abandon Sandy, Murray, Cottonwood, Granger-Hunter and South Salt Lake plants. Convey flows from Sandy to Tri-Community and from Murray, Cottonwood, Granger-Hunter and South Salt Lake to Salt Lake City Suburban No. 1. Modify and expand Tri-Community, Salt Lake County Suburban No. 1 and Salt Lake City plants. Treatment level IV.
Alternative 6	Abandon Sandy, Tri-Community, Murray, Cottonwood, Granger-Hunter and South Salt Lake, and convey flows to Salt Lake City Suburban No. 1. Expand and modify Salt Lake City Suburban No. 1 and Salt Lake City plants. Treatment level IV.
Alternative 7	Abandon all plants except Salt Lake City Plant. Convey all flows to modified and expanded Salt Lake City plant. Treatment level IV.
Alternative 8	As 7, but with level III treatment and an outfall to Great Salt Lake.
Alternative 9	As Alternative 5, but with treatment level III.
Alternative 10	As Alternative 6, but with treatment level III.
Alternative 11	As Alternative 7, but with treatment level III.
Alternative 12	As Alternative 10, but Salt Lake City employs level III treatment with an outfall to the Great Salt Lake.

Alternative Courses of Action--West Salt Lake County

Three small communities, Magna, Lark City and Copperton City, collect and treat wastewaters in West Salt Lake County Magna, the largest of the three, presently treats 1 MGD in a trickling filter plant. Effluent is used for irrigation during the growing season and is otherwise discharged to Kersey Creek, a small stream that flows to the marshes bordering the Great Salt Lake. Lark City wastes are conveyed to lagoons, where they evaporate and percolate into the ground. Copperton City discharges its wastes


GREAT SALT LAKE
ALTERNATIVE NO. 1
RIVER
MAGNA
SALT LAKE CITY-IV
IV
GRANGER HUNTER
SOUTH SALT LAKE-IV
COPPERTON
SALT LAKE SUB #1-IV
SALT LAKE CO. COTTONWOOD-IV
MURRAY-IV
LARK
TRI-COMMUNITY-IV
SANDY-IV
JORDAN
UTAH LAKE

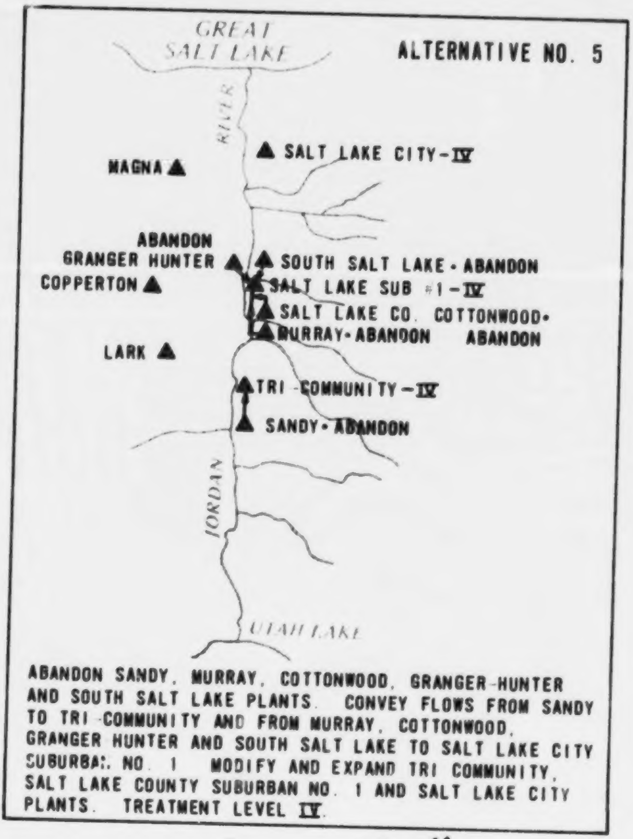
MODIFY AND EXPAND ALL EXISTING PLANTS AT EXISTING LOCATIONS.


GREAT SALT LAKE
ALTERNATIVE NO. 2
RIVER
MAGNA
SALT LAKE CITY-III
III
GRANGER HUNTER
SOUTH SALT LAKE-III
COPPERTON
SALT LAKE SUB #1-III
SALT LAKE CO. COTTONWOOD-III
MURRAY-III
LARK
TRI-COMMUNITY-III
SANDY-III
JORDAN
UTAH LAKE

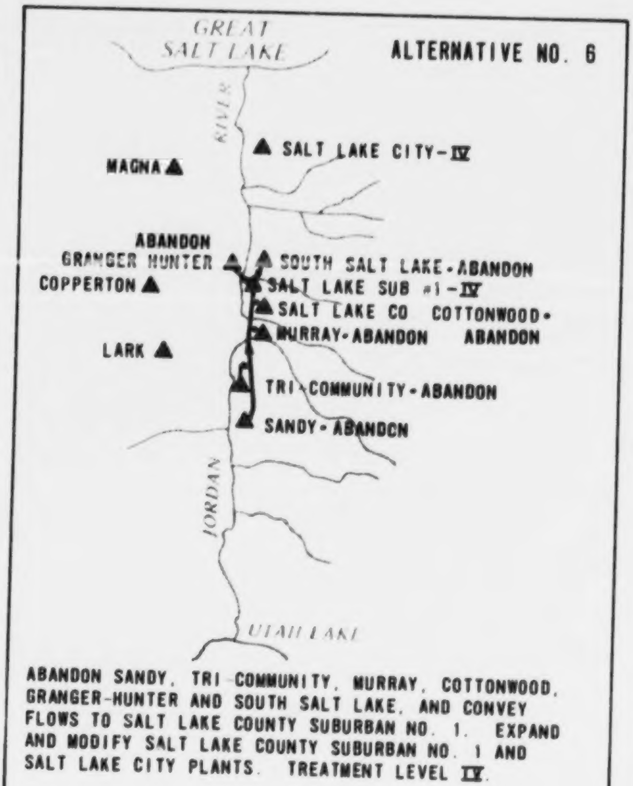
SAME AS 1. BUT LEVEL III TREATMENT........................

CO

ABA
LAK
COM
HUN
URB
COT
LAK


GREAT SALT LAKE
ALTERNATIVE NO. 5
RIVER
MAGNA
SALT LAKE CITY-IV
ABANDON
GRANGER HUNTER
SOUTH SALT LAKE-ABANDON
COPPERTON
SALT LAKE SUB #1-IV
SALT LAKE CO. COTTONWOOD-ABANDON
MURRAY-ABANDON
LARK
TRI-COMMUNITY-IV
SANDY-ABANDON
JORDAN
UTAH LAKE

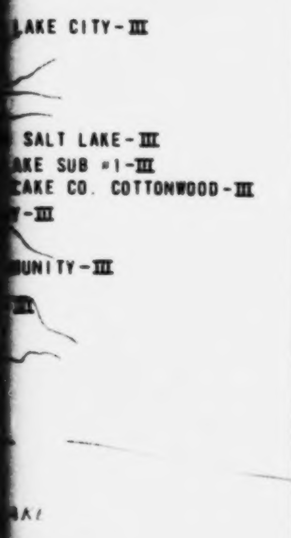
ABANDON SANDY, MURRAY, COTTONWOOD, GRANGER-HUNTER AND SOUTH SALT LAKE PLANTS. CONVEY FLOWS FROM SANDY TO TRI-COMMUNITY AND FROM MURRAY, COTTONWOOD, GRANGER HUNTER AND SOUTH SALT LAKE TO SALT LAKE CITY SUBURBAN NO. 1 MODIFY AND EXPAND TRI COMMUNITY, SALT LAKE COUNTY SUBURBAN NO. 1 AND SALT LAKE CITY PLANTS. TREATMENT LEVEL IV.


GREAT SALT LAKE
ALTERNATIVE NO. 6
RIVER
MAGNA
SALT LAKE CITY-IV
ABANDON
GRANGER HUNTER
SOUTH SALT LAKE-ABANDON
COPPERTON
SALT LAKE SUB #1-IV
SALT LAKE CO COTTONWOOD-ABANDON
MURRAY-ABANDON
LARK
TRI-COMMUNITY-ABANDON
SANDY-ABANDON
JORDAN
UTAH LAKE

ABANDON SANDY, TRI-COMMUNITY, MURRAY, COTTONWOOD, GRANGER-HUNTER AND SOUTH SALT LAKE, AND CONVEY FLOWS TO SALT LAKE COUNTY SUBURBAN NO. 1. EXPAND AND MODIFY SALT LAKE COUNTY SUBURBAN NO. 1 AND SALT LAKE CITY PLANTS. TREATMENT LEVEL IV.

A 13-16

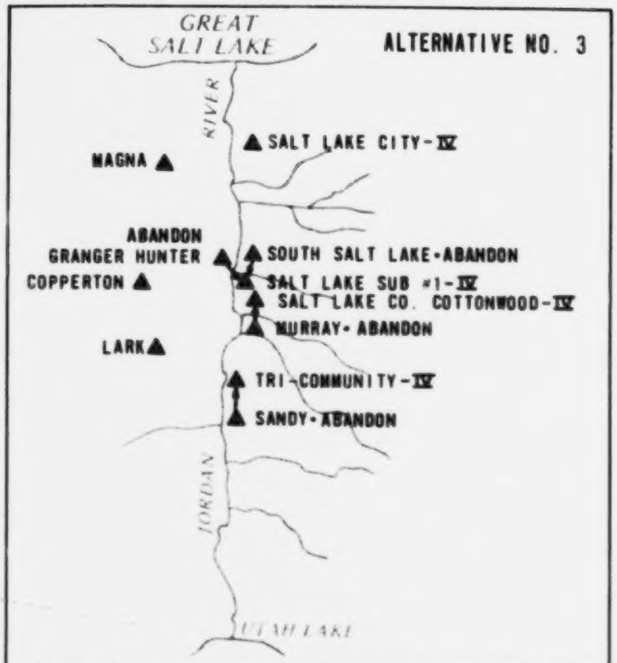
ALTERNATIVE NO. 2



LAKE CITY-III
SALT LAKE-III
AKE SUB #1-III
LAKE CO. COTTONWOOD-III
-III
UNITY-III
III
AKE

ATMENT........................

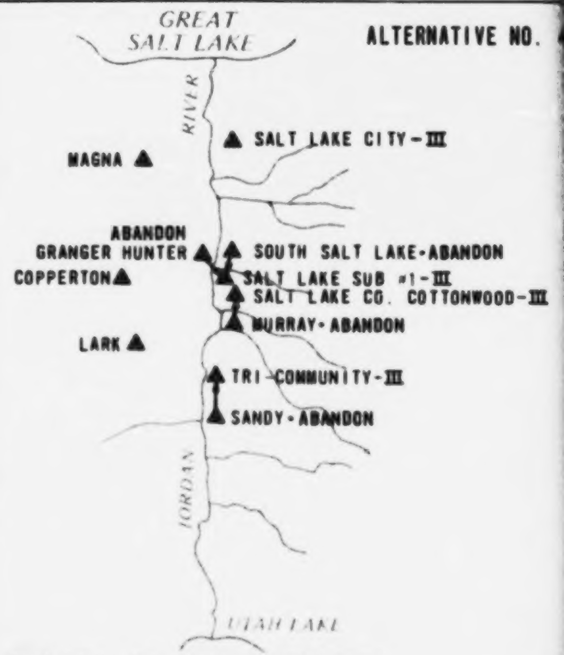
ALTERNATIVE NO. 3



GREAT SALT LAKE
RIVER
SALT LAKE CITY-IV
MAGNA
ABANDON
GRANGER HUNTER
SOUTH SALT LAKE-ABANDON
COPPERTON
SALT LAKE SUB #1-IV
SALT LAKE CO. COTTONWOOD-IV
MURRAY-ABANDON
LARK
TRI-COMMUNITY-IV
SANDY-ABANDON
JORDAN
UTAH LAKE

ABANDON SANDY, MURRAY, GRANGER-HUNTER AND SOUTH SALT LAKE PLANTS. CONVEY FLOWS FROM SANDY TO TRI-COMMUNITY, MURRAY TO COTTONWOOD AND FROM GRANGER-HUNTER AND SOUTH SALT LAKE TO SALT LAKE CITY SUBURBAN NO. 1. MODIFY AND EXPAND TRI-COMMUNITY, COTTONWOOD, SALT LAKE CITY SUBURBAN NO. 1 AND SALT LAKE CITY PLANTS. TREATMENT LEVEL IV.

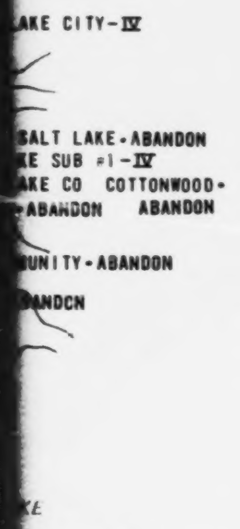
ALTERNATIVE NO.



GREAT SALT LAKE
RIVER
SALT LAKE CITY-III
MAGNA
ABANDON
GRANGER HUNTER
SOUTH SALT LAKE-ABANDON
COPPERTON
SALT LAKE SUB #1-III
SALT LAKE CO. COTTONWOOD-III
MURRAY-ABANDON
LARK
TRI-COMMUNITY-III
SANDY-ABANDON
JORDAN
UTAH LAKE

SAME AS 3, BUT LEVEL III TREATMENT..........

ALTERNATIVE NO. 6



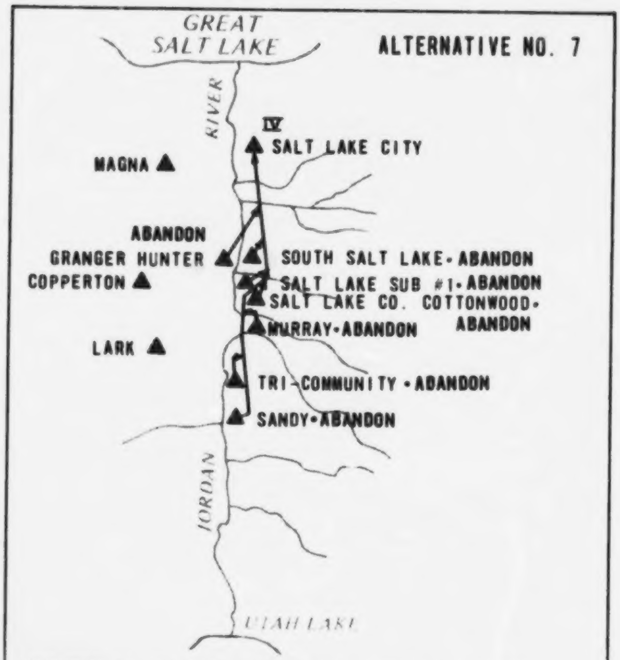
LAKE CITY-IV
SALT LAKE-ABANDON
KE SUB #1-IV
AKE CO COTTONWOOD-
-ABANDON ABANDON
UNITY-ABANDON
ANDON
KE

MURRAY, COTTONWOOD,
LAKE, AND CONVEY
URBAN NO. 1. EXPAND
UBURBAN NO. 1 AND
ENT LEVEL IV.

FIGURE 13-2
SALT LAKE COUNTY
MUNICIPAL WASTEWATER
MANAGEMENT ALTERNATIVES

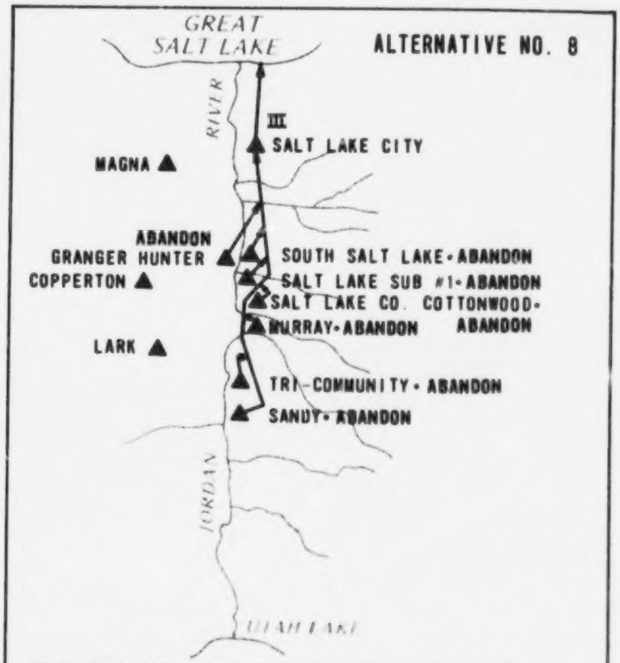
B

ALTERNATIVE NO. 7

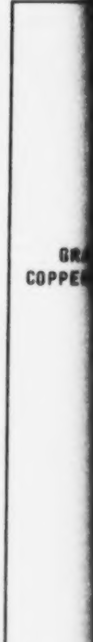

GREAT SALT LAKE
RIVER
IV
SALT LAKE CITY
MAGNA
ABANDON
GRANGER HUNTER
SOUTH SALT LAKE-ABANDON
COPPERTON
SALT LAKE SUB #1-ABANDON
SALT LAKE CO. COTTONWOOD-ABANDON
MURRAY-ABANDON
LARK
TRI-COMMUNITY-ABANDON
SANDY-ABANDON
JORDAN
UTAH LAKE

ABANDON ALL PLANTS EXCEPT SALT LAKE CITY PLANT. CONVEY ALL FLOWS TO MODIFIED AND EXPANDED SALT LAKE CITY PLANT. TREATMENT LEVEL IV.

ALTERNATIVE NO. 8

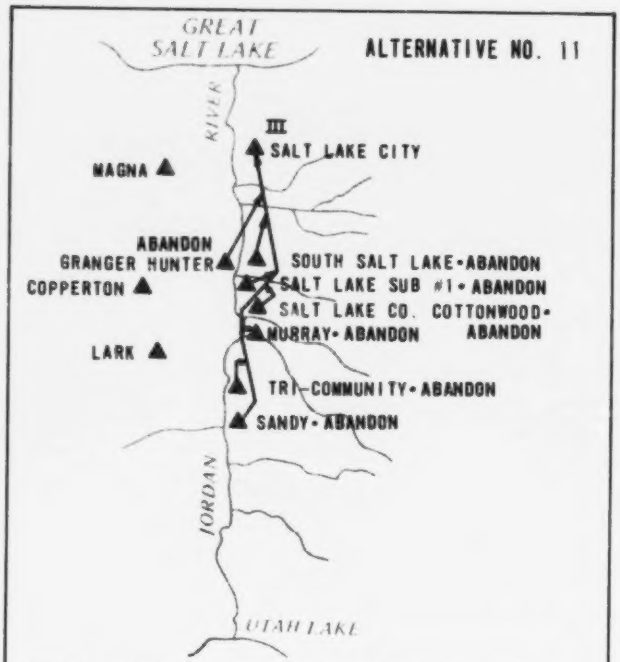

GREAT SALT LAKE
RIVER
III
SALT LAKE CITY
MAGNA
ABANDON
GRANGER HUNTER
SOUTH SALT LAKE-ABANDON
COPPERTON
SALT LAKE SUB #1-ABANDON
SALT LAKE CO. COTTONWOOD-ABANDON
MURRAY-ABANDON
LARK
TRI-COMMUNITY-ABANDON
SANDY-ABANDON
JORDAN
UTAH LAKE

AS 7, BUT WITH LEVEL III TREATMENT AND AN OUTFALL TO GREAT SALT LAKE.



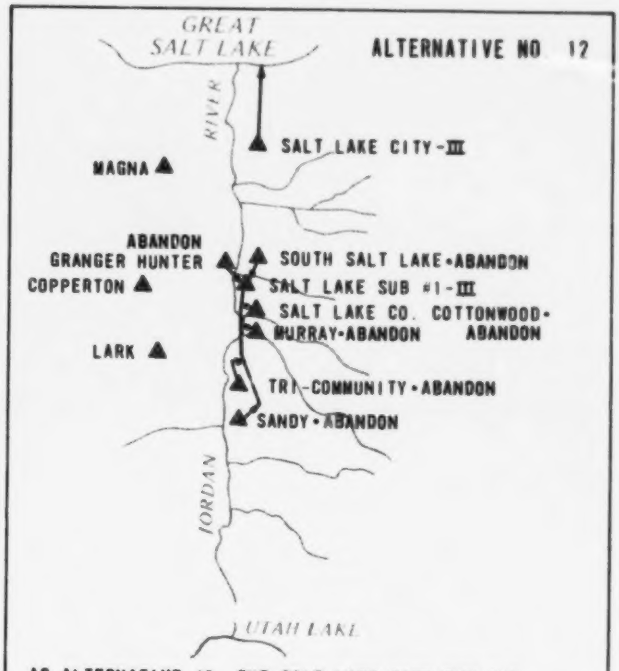
AS ALT

ALTERNATIVE NO. 11

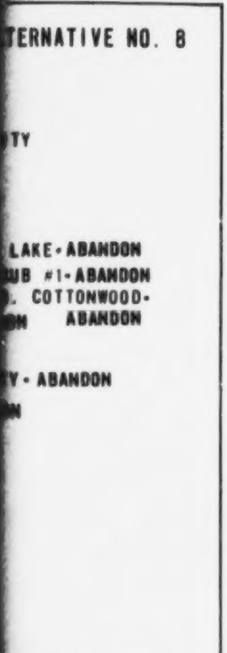

GREAT SALT LAKE
RIVER
III
SALT LAKE CITY
MAGNA
ABANDON
GRANGER HUNTER
SOUTH SALT LAKE-ABANDON
COPPERTON
SALT LAKE SUB #1-ABANDON
SALT LAKE CO. COTTONWOOD-ABANDON
MURRAY-ABANDON
LARK
TRI-COMMUNITY-ABANDON
SANDY-ABANDON
JORDAN
UTAH LAKE

AS ALTERNATIVE 7, BUT WITH TREATMENT LEVEL III........

ALTERNATIVE NO 12

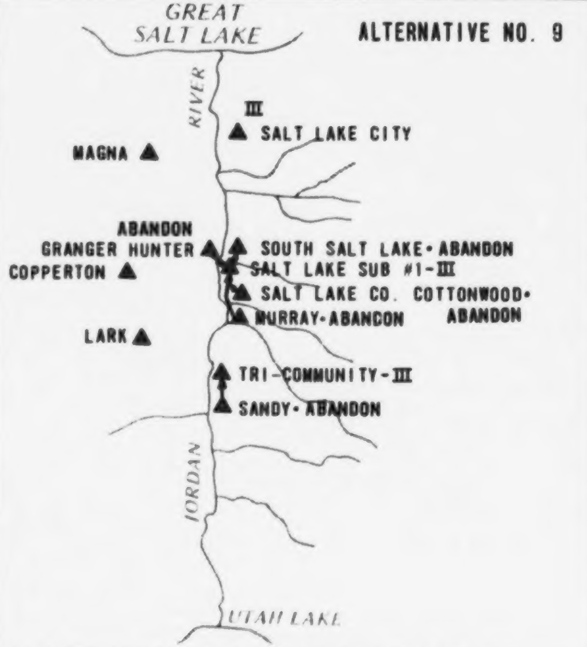

GREAT SALT LAKE
RIVER
SALT LAKE CITY-III
MAGNA
ABANDON
GRANGER HUNTER
SOUTH SALT LAKE-ABANDON
COPPERTON
SALT LAKE SUB #1-III
SALT LAKE CO. COTTONWOOD-ABANDON
MURRAY-ABANDON
LARK
TRI-COMMUNITY-ABANDON
SANDY-ABANDON
JORDAN
UTAH LAKE

AS ALTERNATIVE 10, BUT SALT LAKE CITY EMPLOYS LEVEL III TREATMENT WITH AN OUTFALL TO THE GREAT SALT LAKE.



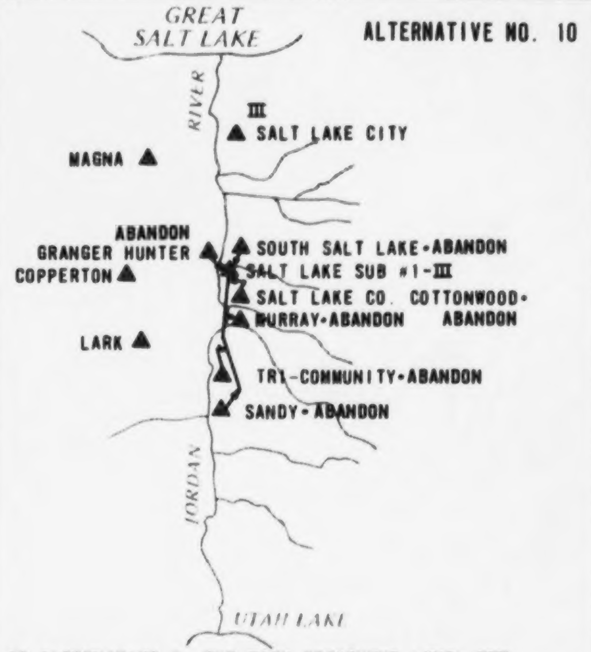
TERNATIVE NO. 8
TY
LAKE-ABANDON
SUB #1-ABANDON
. COTTONWOOD-
N ABANDON
Y-ABANDON
N

AND AN OUTFALL



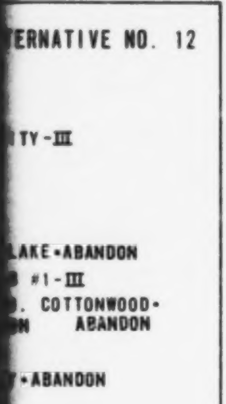
GREAT SALT LAKE
ALTERNATIVE NO. 9
RIVER
III
SALT LAKE CITY
MAGNA
ABANDON
GRANGER HUNTER
SOUTH SALT LAKE-ABANDON
COPPERTON
SALT LAKE SUB #1-III
SALT LAKE CO. COTTONWOOD-
MURRAY-ABANDON
ABANDON
LARK
TRI-COMMUNITY-III
SANDY-ABANDON
JORDAN
UTAH LAKE

AS ALTERNATIVE 5, BUT WITH TREATMENT LEVEL III........



GREAT SALT LAKE
ALTERNATIVE NO. 10
RIVER
III
SALT LAKE CITY
MAGNA
ABANDON
GRANGER HUNTER
SOUTH SALT LAKE-ABANDON
COPPERTON
SALT LAKE SUB #1-III
SALT LAKE CO. COTTONWOOD-
MURRAY-ABANDON
ABANDON
LARK
TRI-COMMUNITY-ABANDON
SANDY-ABANDON
JORDAN
UTAH LAKE

AS ALTERNATIVE 6, BUT WITH TREATMENT LEVEL III........



TERNATIVE NO. 12
TY-III
LAKE-ABANDON
#1-III
. COTTONWOOD-
N ABANDON
Y-ABANDON

TY EMPLOYS
TO THE GREAT

FIGURE 13-2 (Continued)
SALT LAKE COUNTY
MUNICIPAL WASTEWATER
MANAGEMENT ALTERNATIVES

B

untreated to a totally contained waste acid pond operated by Kennecott. Neither the Lark City nor the Copperton City discharge is expected to increase significantly in volume in the next 20 years.

The remoteness of these communities from larger communities or sources of dilution water eliminates conveyance of waste as an alternative course of action. In view of the small size of the discharges and their relative insignificance with regard to basin-wide water quality, it would appear that the most appropriate course of action is that each community, with the exception of Magna, continue to handle its wastes independently in the same manner as is presently used. If water quality or health problems attributable to waste disposal practices should manifest themselves in the future, further action should be taken at this time.

At Magna, it will be necessary to improve treatment to level III in order to meet the State's interim effluent requirements.

Alternative Courses of Action--the Canyonlands

Preservation of the high levels of water quality generally prevailing in the canyon streams in the face of extreme pressure for development and recreational use is probably one of the most significant environmental problems that exist within the basin. In view of the relatively unknown relationship between canyon use and water quality, no specific alternative facility plans can be identified in this study. Continual monitoring of water quality in the streams as canyon use increases will be necessary to determine the need for action.

Certain principles will have to be observed: All wastes generated in the canyons should be conveyed out of the canyons by sewer or tank truck. Land use planning must be conducted with preservation of water quality in mind. If other measures prove ineffective, day use of the canyons may have to be restricted.

Evaluation of Alternatives

Each alternative was evaluated by the study consultants as described in Chapter 12. The results of the evaluation are summarized in Table 13-7. Detailed evaluation matrixes are included in Appendix 13-A. This material was included in a briefing document describing alternative courses of action for treatment and disposal of municipal wastewaters and their costs. The document was mailed to concerned individuals and agencies in December 1973. A public meeting to discuss the alternatives was held in

Table 13-7

SALT LAKE COUNTY - SUMMARY OF EVALUATION OF ALTERNATIVES[a]

Alternative	1	2	3	4	5	6	7	8	9	10	11	12
No. of Plants	8	8	4	4	3	2	1	1	3	2	1	2
Treatment Level	IV	III	IV	III	IV	IV	IV	III	III	III	III	III
Capital Cost	66.33	32.41	66.69	38.56	64.04	62.90	76.75	85.57	40.75	41.25	59.99	55.00
Amortized Capital	5.43	2.58	5.34	3.10	5.21	4.88	5.84	6.32	3.18	3.17	4.51	4.15
Operation and Maintenance	8.15	5.22	6.77	4.36	6.12	5.33	4.34	2.96	3.97	3.55	2.82	3.63
Total Annual Cost	13.58	7.80	12.11	7.46	11.33	10.21	10.18	9.28	7.15	6.72	7.33	7.78
Subjective Ratings												
Environmental	233	195	240	202	273	280	339	339	240	247	320	247
Feasibility	210	220	209	219	199	165	154	129	200	182	155	165
Effectiveness	130	144	160	166	190	220	228	240	183	213	221	206

[a] All costs are expressed in millions of dollars.

Table 13-8

SALT LAKE COUNTY - EFFECT OF REDUCED OPERATION AND MAINTENANCE COST[a]

Alternative	1	2	3	4	5	6	7	8	9	10	11	12
Adjusted Annual Operation and Maintenance Cost	2.71	1.74	2.26	1.45	2.04	1.78	1.45	0.98	1.32	1.18	0.94	1.29
Adjusted Total Annual Cost	8.15	4.32	7.59	4.55	7.25	6.66	7.38	7.31	4.50	4.35	5.45	5.44

[a] All costs expressed in millions of dollars.

Salt Lake County in January 1974. Local opinion did not appear to favor any particular alternative although some reluctance to alter present arrangements for sewage collection, treatment and disposal was expressed.

In early April, a meeting was held between the State Division of Health, their consultants, and the technical representatives of the sewage agencies involved. Opinions were voiced that the basin study estimates of operation and maintenance cost were too high and that the wastewater flow projections were too low. In view of the conservative nature of the basin study flow projections and the flow reductions likely to result from the infiltration/inflow control programs, the basin study flow projections were retained in the subsequent analysis. To determine the effect of reducing the operation and maintenance costs to one-third of the original estimates on the ranking of the alternatives, an adjusted total annual cost is shown in Table 13-8. It is almost inevitable that the operation and maintenance costs will be considerably higher than this one-third figure, but this figure should provide a lower cost boundary.

Analysis of Alternatives

The ranking of the alternatives with respect to total annual cost are displayed in Table 13-9. To meet the 1980 interim standards, it will be necessary to upgrade treatment to level III. These costs indicate that the most cost-effective way to attain effluent level III would be to regionalize at two locations: Salt Lake City and Salt Lake City Suburban Sanitary District No. 1. Upgrading all eight existing plants would be the least attractive option. Adjusting the operation and maintenance costs results in some reordering of the alternatives. However, regionalization at two locations is still the least costly option.

If it becomes necessary to provide treatment level IV in order to meet the Class "C" stream standards, and this is more likely on the Jordan River than at any other location in the basin, the ranking of alternatives is less affected by the operation and maintenance cost reduction to one-third of original costs. In both the original and adjusted cases, with level IV

Table 13-9

SALT LAKE COUNTY - RANKING OF ALTERNATIVES WITH RESPECT TO TOTAL ANNUAL COST

Degree of Regionalization	Level III Treatment			Level IV Treatment		
	Alternative	Original	Adjusted	Alternative	Original	Adjusted
8 plants	2	5	1	1	5	5
4 plants	4	4	3	3	4	4
3 plants	9	2	3	5	3	2
2 plants	10	1	1	6	1	1
1 plant	11	3	5	7	1	2

treatment the least expensive options are regionalization at one or two locations. The original estimates indicate that regionalization at one or at two locations is equally advantageous, while the adjusted estimates indicate that the two-plant concept offers the least total annual cost.

In conclusion, it would appear that regionalization at two locations provides the best option regardless of the treatment level or the exact cost of operation and maintenance. Many factors other than cost support the selection of the two-plant concept, i.e., regionalization at Salt Lake City and Salt Lake City Suburban Sanitary District No. 1. Consolidation of all the plants presently discharging to the Jordan River at a single location affords the benefits of regionalization such as improved plant operation and reliability while retaining present river flows for downstream water rights and maintaining a source of reclaimed water in the mid-Valley. Eliminating municipal discharges to the Jordan south of 33rd South will result in an improvement in the aquatic environment of the Jordan River Parkway, without reducing the total river flow to unacceptably low levels.

MUNICIPAL WASTEWATER MANAGEMENT ALTERNATIVES FOR UTAH AND JUAB COUNTIES

For the purposes of this analysis, Utah County has been divided into three areas: Northern, Central and Southern Utah and Northern Juab counties.

Northern Utah County is defined as that area served by the Lehi, American Fork, Pleasant Grove and Orem treatment plants. Presently unsewered areas such as Alpine, Manila and Lindon are assumed to be sewered and connected to an existing sewer system during the 20-year planning period. The four existing wastewater treatment plants in Northern Utah County are located close to Utah Lake. Central Utah County is defined as that area served by the Provo, Springville, Spanish Fork, Payson and Salem treatment plants. Presently unsewered areas such as Mapleton and Salem Hills are assumed to be sewered and connected to existing sewer systems within the 20-year planning period. Southern Utah County and Northern Juab County includes the small communities of Santaquin, Goshen, Mona and Nephi.

Present and projected wastewater flows are shown in Table 13-10. Waste load allocations and required treatment levels are shown in Table 13-11.

Table 13-10

PRESENT AND PROJECTED WASTEWATER FLOWS[a]

UTAH COUNTY

Source	1972	1980	1995
Lehi City	0.7	0.8	1.1
American Fork	1.2	1.5	1.8
Pleasant Grove	1.1	1.3	1.5
Orem	3.2	4.1	6.0
Provo	13.5	14.0	16.8
Springville	2.3	2.4	2.7
Spanish Fork	2.4	2.9	3.4
Salem	0.1	0.2	0.2
Payson	0.5	0.7	0.8

[a] Assuming elimination of excessive infiltration and inflow to the collection system.

Table 13-11

MUNICIPAL WASTE LOAD ALLOCATIONS AND TREATMENT LEVELS[a]

UTAH COUNTY

Source	Effluent Quality BOD, mg/1	Waste Load Alloc. BOD, lbs/day	Required Treatment Level	Probability of Compliance with W.Q. Standards
Lehi City	10	67	III	Fair
American Fork	10	125	III	Good
Pleasant Grove	10	108	III	Fair
Orem	10	342	III	Fair
Provo	10	1,166	III	Fair
Springville	10	200	III	Fair
Spanish Fork	10	242	III	Fair
Salem	10	17	III	Good
Payson	10	58	III	Good

[a] Assessment of the probability that application of the required treatment level will result in water quality standard compliance in the receiving waters.

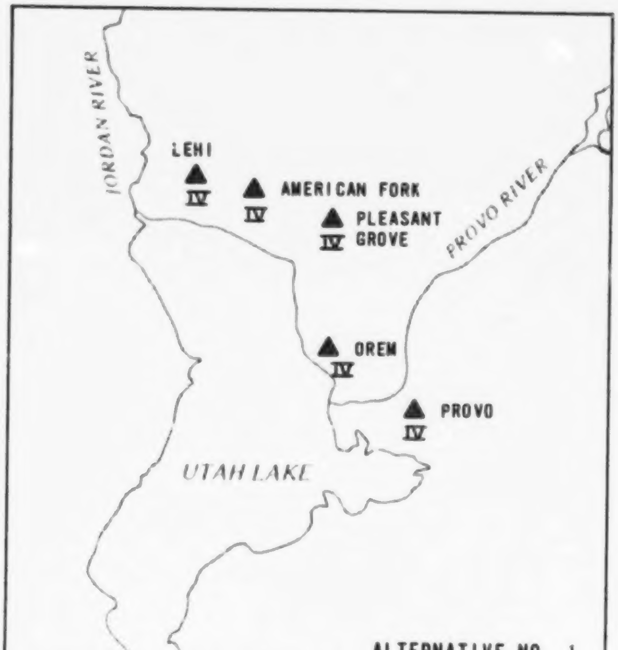
Alternative Courses of Action--Northern Utah County

The most promising alternatives for Northern Utah County are described below and illustrated in Figure 13-3.

Alternative 1	Modify and expand existing plants at existing locations. Level IV treatment at all plants.
Alternative 2	Same as Alternative 1, but treatment level III.
Alternative 3	Modify and expand existing plants at existing locations. Level III treatment and lake outfalls at each point.
Alternative 4	Modify and expand existing plants at existing locations. Level IV treatment at Lehi, Pleasant Grove and Orem. Level III treatment at American Fork with outfall extended into lake.
Alternative 5	Convey flows from Lehi, Pleasant Grove and American Fork to new regional plant near American Fork. Orem remains separate. Treatment level IV at all plants.
Alternative 6	As Alternative 5, but level III treatment.
Alternative 7	Convey flows from Lehi, Pleasant Grove and American Fork to new regional plant near American Fork. Orem remains separate. Level III treatment with outfalls to lake from Orem and regional plant.
Alternative 8	Convey flows from Lehi, Pleasant Grove and American Fork to expanded Orem plant. Implement treatment level III with lake outfall.
Alternative 9	Same as Alternative 8, but with level IV treatment at Orem plant; discharge to slough.
Alternative 10	Convey flows from Lehi, Pleasant Grove, American Fork and Orem to new regional plant near Provo. Treatment level III with lake outfall.
Alternative 11	Same as Alternative 10, but with level IV treatment at new regional plant near Provo. Discharge to Provo Bay.
Alternative 12	As Alternative 11, but with level III treatment.

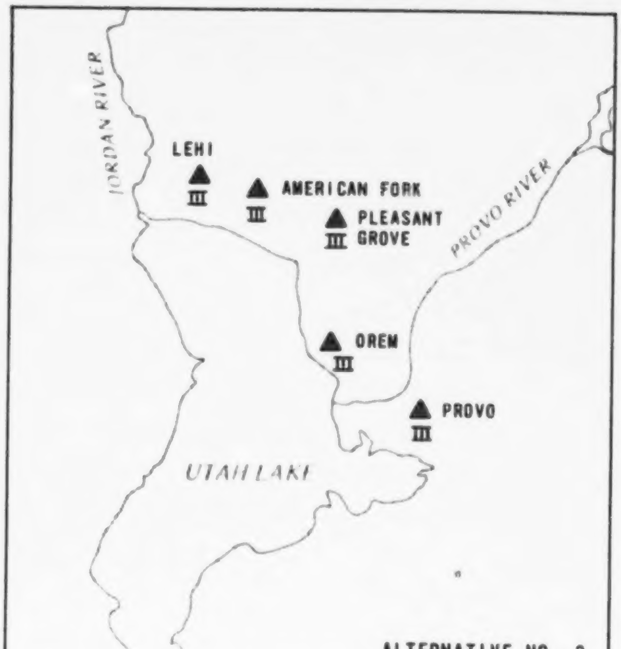
Alternative Courses of Action--Central Utah County

The most promising alternatives for Central Utah County are described below and illustrated in Figure 13-4.


JORDAN RIVER
LEHI
IV
AMERICAN FORK
IV
PLEASANT GROVE
IV
PROVO RIVER
OREM
IV
PROVO
IV
UTAH LAKE

ALTERNATIVE NO. 1

MODIFY AND EXPAND EXISTING PLANTS AT EXISTING LOCATIONS LEVEL IV TREATMENT AT ALL PLANTS

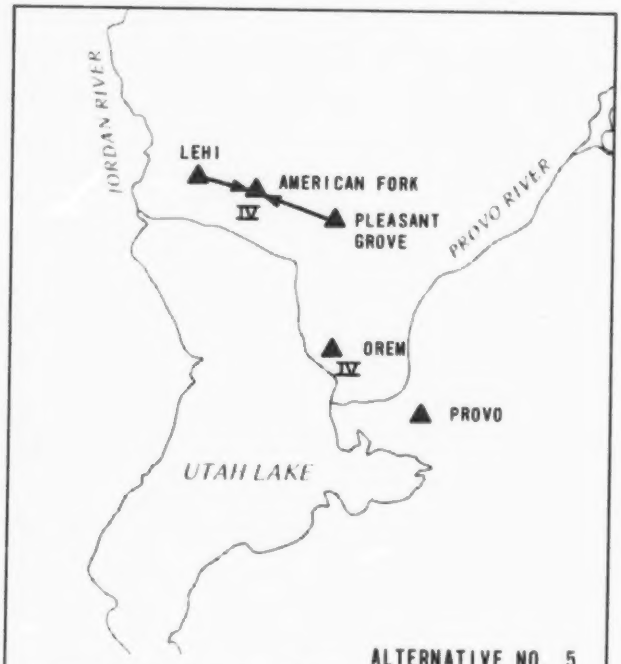

JORDAN RIVER
LEHI
III
AMERICAN FORK
III
PLEASANT GROVE
III
PROVO RIVER
OREM
III
PROVO
III
UTAH LAKE

ALTERNATIVE NO. 2

SAME AS ALTERNATIVE 1, BUT TREATMENT LEVEL III........

JORDAN RIVER

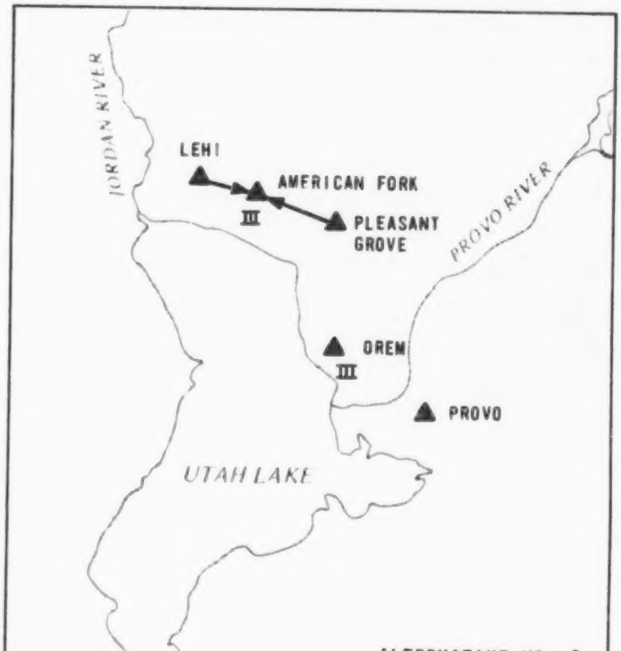
MODIFY
LOCATIO
AT EACH


JORDAN RIVER
LEHI
AMERICAN FORK
IV
PLEASANT GROVE
PROVO RIVER
OREM
IV
PROVO
UTAH LAKE

ALTERNATIVE NO. 5

CONVEY FLOWS FROM LEHI, PLEASANT GROVE AND AMERICAN FORK OREM REAMINS SEPARATE TREATMENT LEVEL IV AT ALL PLANTS.

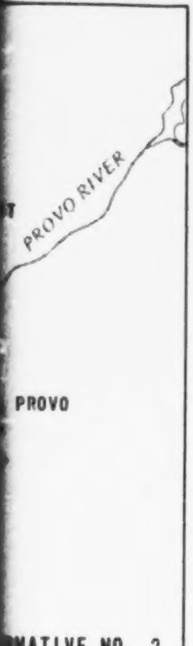
13-26


JORDAN RIVER
LEHI
AMERICAN FORK
III
PLEASANT GROVE
PROVO RIVER
OREM
III
PROVO
UTAH LAKE

ALTERNATIVE NO. 6

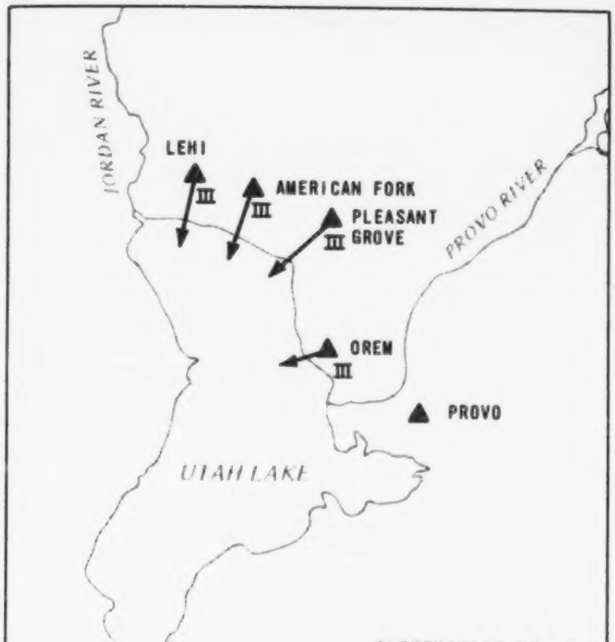
AS ALTERNATIVE 5, BUT LEVEL III TREATMENT ....

A


T
PROVO RIVER
PROVO

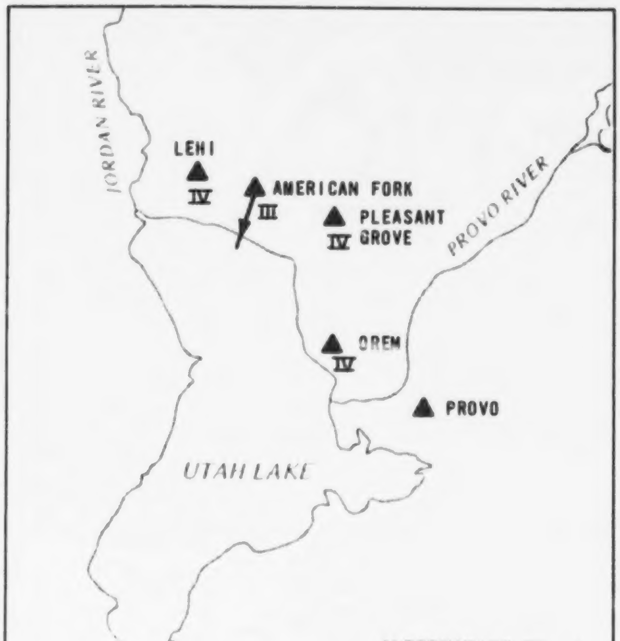
RNATIVE NO. 2

LEVEL III........


JORDAN RIVER
LEHI
III
AMERICAN FORK
III
PLEASANT GROVE
III
PROVO RIVER
OREM
III
PROVO
UTAH LAKE

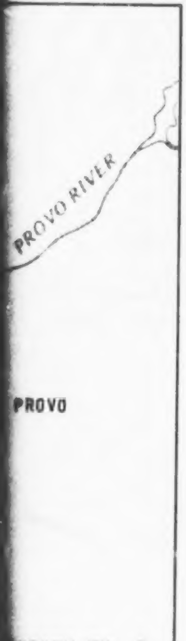
ALTERNATIVE NO. 3

MODIFY AND EXPAND EXISTING PLANTS AT EXISTING LOCATIONS. LEVEL III TREATMENT AND LAKE OUTFALLS AT EACH POINT.


JORDAN RIVER
LEHI
IV
AMERICAN FORK
III
PLEASANT GROVE
IV
PROVO RIVER
OREM
IV
PROVO
UTAH LAKE

ALTERNATIVE NO. 4

MODIFY AND EXPAND EXISTING PLANTS AT EXISTING LOCATIONS. LEVEL IV TREATMENT AT LEHI, PLEASANT GROVE AND OREM. LEVEL III TREATMENT AT AMERICAN FORK WITH OUTFALL EXTENDED INTO LAKE.

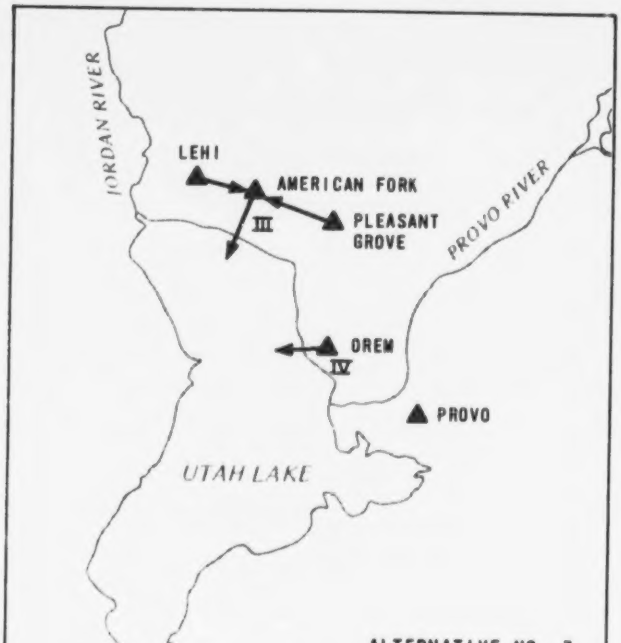

PROVO RIVER
PROVO

ATIVE NO. 6

NT ....

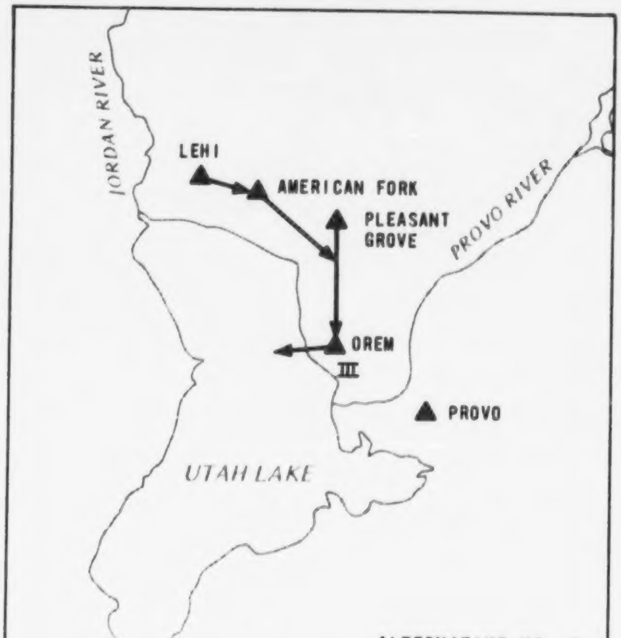
FIGURE 13-3
NORTHERN UTAH COUNTY
MUNICIPAL WASTEWATER
MANAGEMENT ALTERNATIVES

B


JORDAN RIVER
LEHI
AMERICAN FORK
III
PLEASANT GROVE
PROVO RIVER
OREM
IV
PROVO
UTAH LAKE

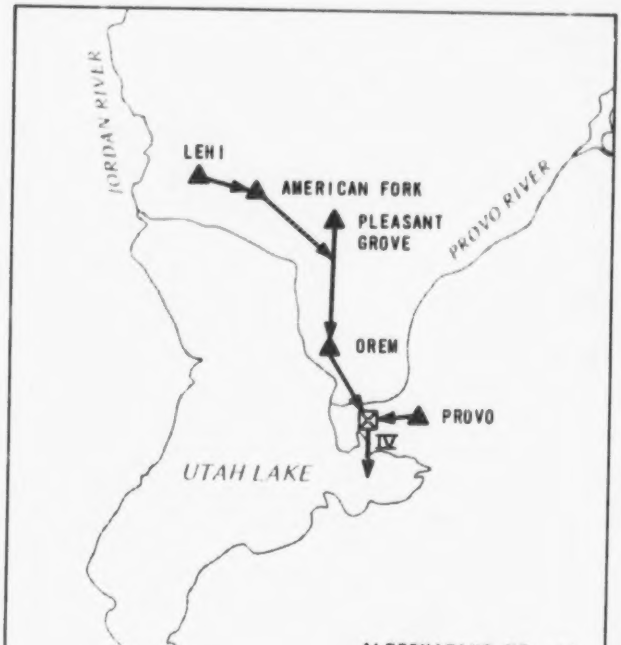
ALTERNATIVE NO. 7

CONVEY FLOWS FROM LEHI, PLEASANT GROVE AND AMERICAN FORK TO NEW REGIONAL PLANT NEAR AMERICAN FORK. OREM REMAINS SEPARATE. LEVEL III TREATMENT WITH OUTFALLS TO LAKE FROM OREM AND REGIONAL PLANT.


JORDAN RIVER
LEHI
AMERICAN FORK
PLEASANT GROVE
PROVO RIVER
OREM
III
PROVO
UTAH LAKE

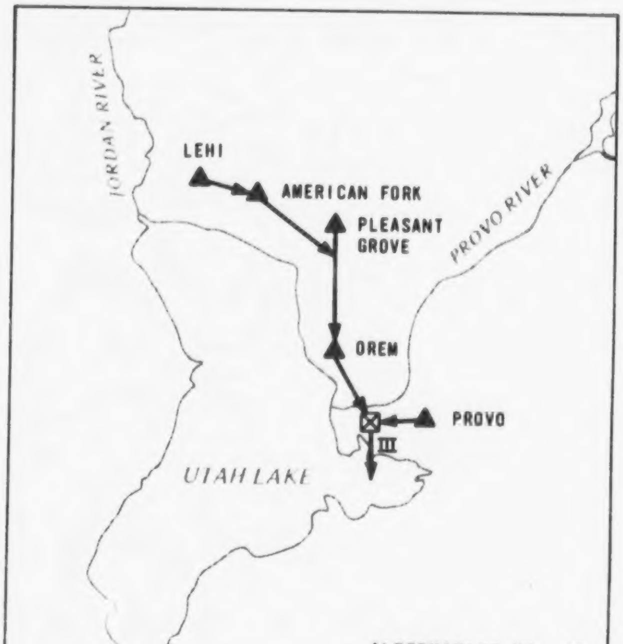
ALTERNATIVE NO. 8

CONVEY FLOWS FROM LEHI, PLEASANT GROVE AND AMERICAN FORK TO EXPANDED OREM PLANT. IMPLEMENT TREATMENT LEVEL III WITH LAKE OUTFALL


JORDAN RIVER
LEHI
AMERICAN FORK
PLEASANT GROVE
PROVO RIVER
OREM
PROVO
IV
UTAH LAKE

ALTERNATIVE NO. 11

SAME AS ALTERNATIVE 10, BUT WITH LEVEL IV TREATMENT AT NEW REGIONAL PLANT NEAR PROVO. DISCHARGE TO PROVO BAY.


JORDAN RIVER
LEHI
AMERICAN FORK
PLEASANT GROVE
PROVO RIVER
OREM
PROVO
III
UTAH LAKE

ALTERNATIVE NO. 12

AS ALTERNATIVE 11, BUT WITH LEVEL III TREATMENT......

13-27

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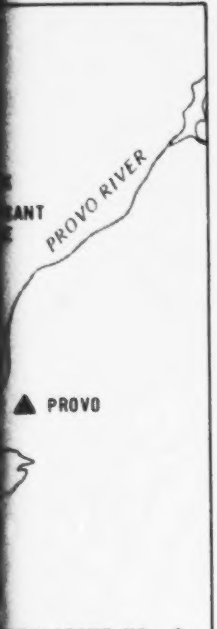
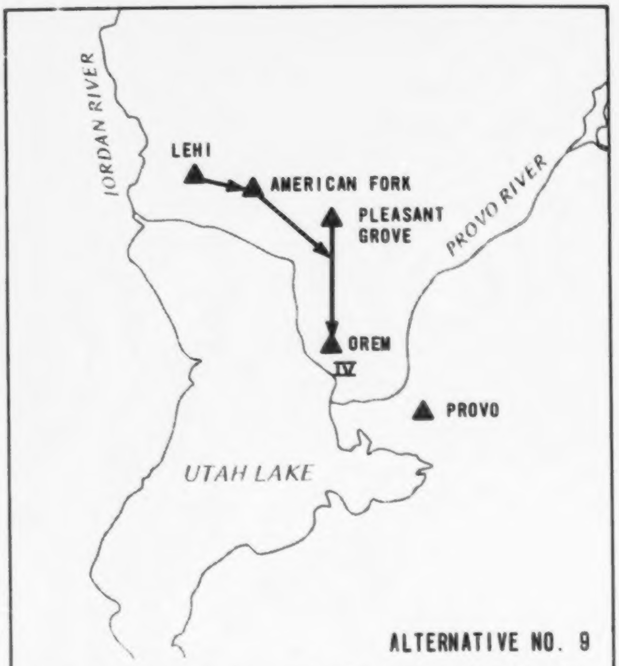

ANT
PROVO RIVER
PROVO

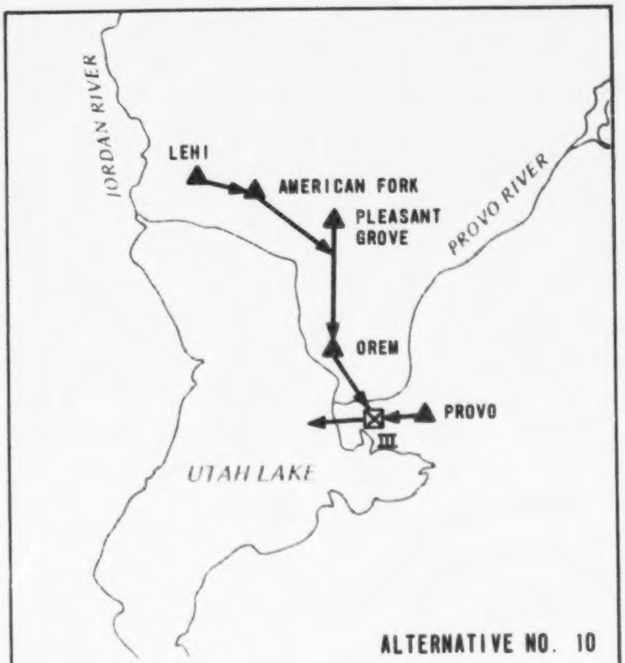
TERNATIVE NO. 8

ROVE AND AMERICAN
EMENT TREATMENT


JORDAN RIVER
LEHI
AMERICAN FORK
PLEASANT
GROVE
PROVO RIVER
OREM
IV
PROVO
UTAH LAKE

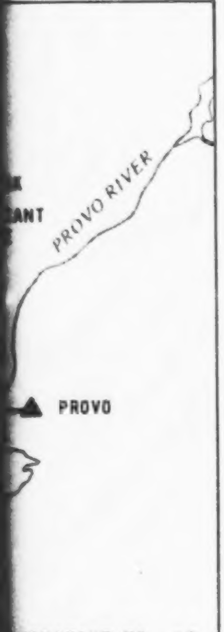
ALTERNATIVE NO. 9

SAME AS ALTERNATIVE 8, BUT WITH LEVEL IV TREATMENT AT OREM PLANT; DISCHARGE TO SLOUGH.


JORDAN RIVER
LEHI
AMERICAN FORK
PLEASANT
GROVE
PROVO RIVER
OREM
PROVO
III
UTAH LAKE

ALTERNATIVE NO. 10

CONVEY FLOWS FROM LEHI, PLEASANT GROVE, AMERICAN FORK AND OREM TO NEW REGIONAL PLANT NEAR PROVO. TREATMENT LEVEL III WITH LAKE OUTFALL.

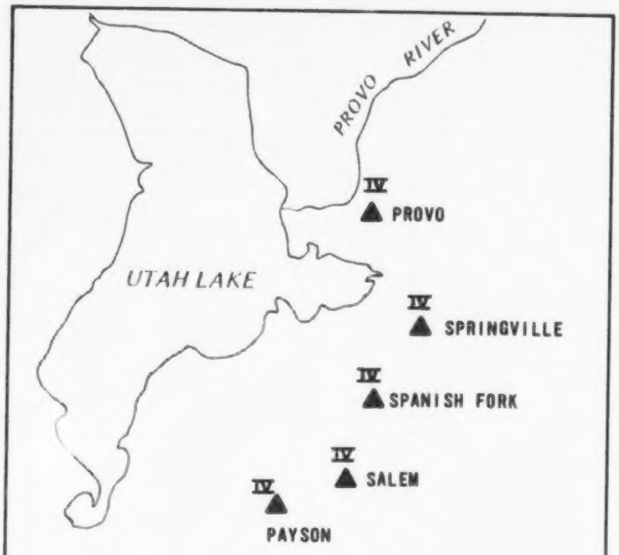

ANT
PROVO RIVER
PROVO

ERNATIVE NO. 12

III TREATMENT......

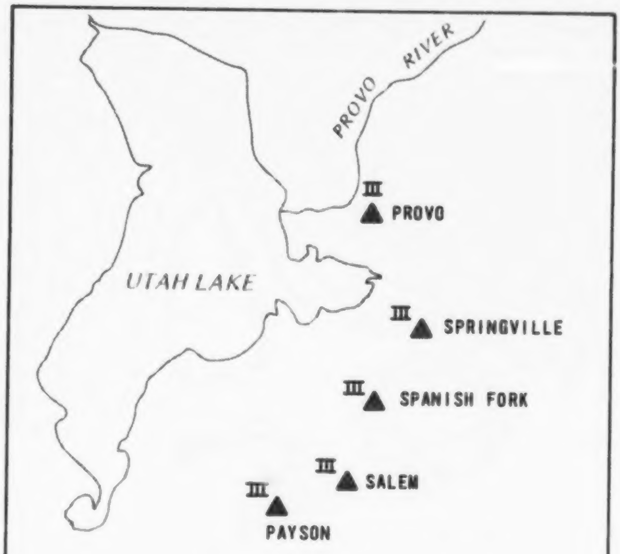
FIGURE 13-3 (Continued)
NORTHERN UTAH COUNTY
MUNICIPAL WASTEWATER
MANAGEMENT ALTERNATIVES

B


PROVO RIVER
UTAH LAKE
IV
PROVO
IV
SPRINGVILLE
IV
SPANISH FORK
IV
SALEM
IV
PAYSON

ALTERNATIVE NO. 1

MODIFY AND EXPAND EXISTING PLANTS AT EXISTING LOCATIONS. TREATMENT LEVEL IV.


PROVO RIVER
UTAH LAKE
III
PROVO
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SPRINGVILLE
III
SPANISH FORK
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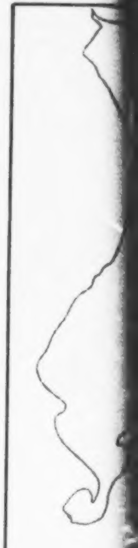
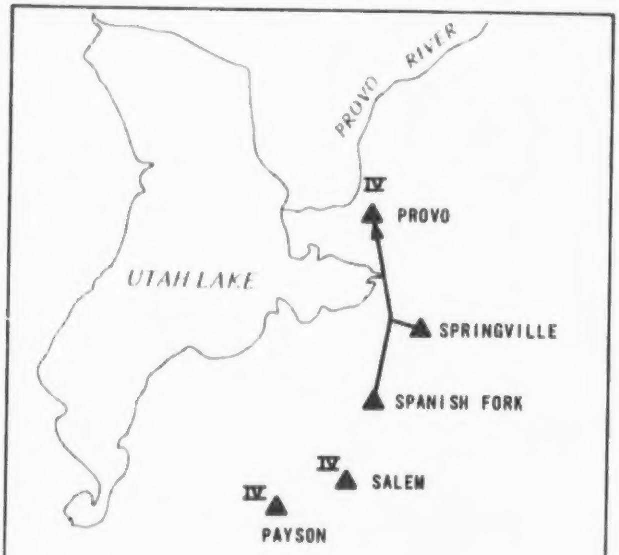
SALEM
III
PAYSON

ALTERNATIVE NO. 2

AS ALTERNATIVE 1, BUT LEVEL III TREATMENT.............

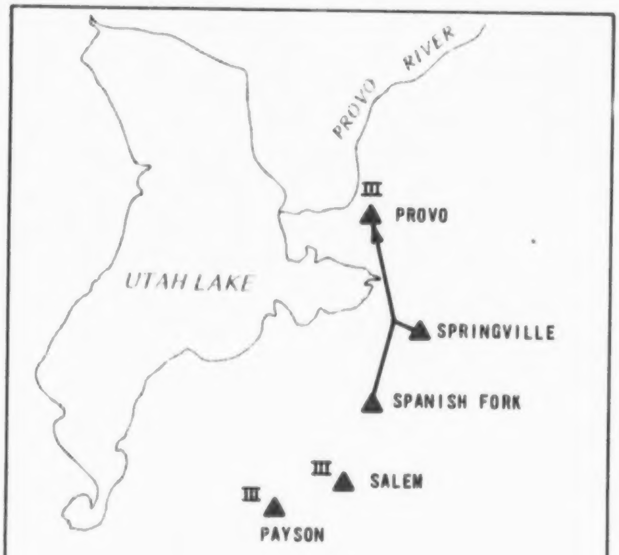


MODIFY AN
LOCATIONS
TREATMENT


PROVO RIVER
UTAH LAKE
IV
PROVO
SPRINGVILLE
SPANISH FORK
IV
SALEM
IV
PAYSON

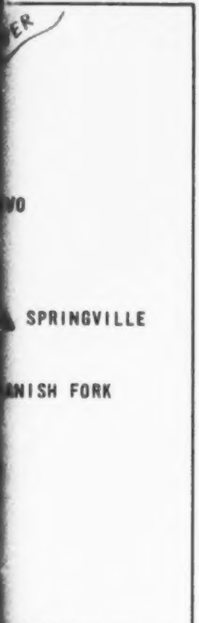
ALTERNATIVE NO. 5

CONVEY FLOWS FROM SPANISH FORK AND SPRINGVILLE TO EXPANDED PROVO PLANT. SALEM AND PAYSON PLANTS REMAIN AT EXISTING LOCATIONS. LEVEL IV TREATMENT.


PROVO RIVER
UTAH LAKE
III
PROVO
SPRINGVILLE
SPANISH FORK
III
SALEM
III
PAYSON

ALTERNATIVE NO. 6

AS ALTERNATIVE 5, BUT LEVEL III TREATMENT.............



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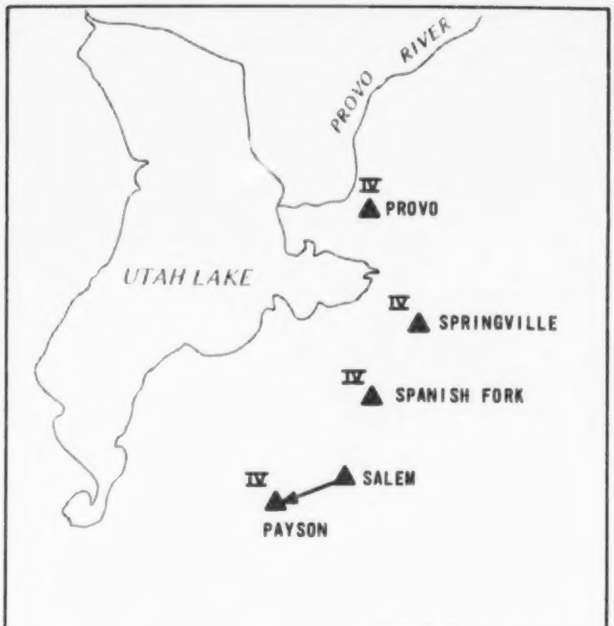
NISH FORK

ERNATIVE NO. 2

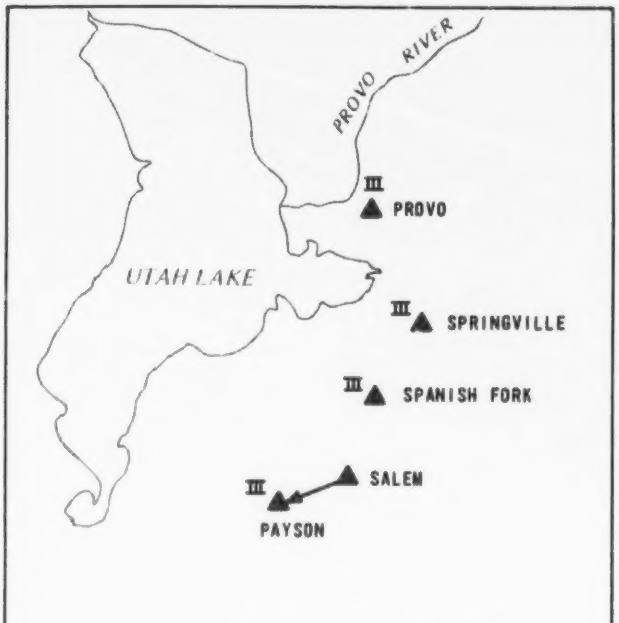
TMENT.............



PROVO RIVER
UTAH LAKE
IV
PROVO
IV
SPRINGVILLE
IV
SPANISH FORK
IV
SALEM
PAYSON

ALTERNATIVE NO. 3

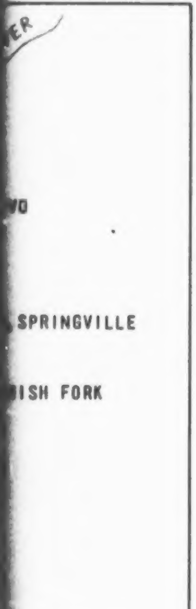
MODIFY AND EXPAND EXISTING PLANTS AT EXISTING LOCATIONS. CONVEY FLOWS FROM SALEM TO PAYSON. TREATMENT LEVEL IV.



PROVO RIVER
UTAH LAKE
III
PROVO
III
SPRINGVILLE
III
SPANISH FORK
III
SALEM
PAYSON

ALTERNATIVE NO. 4

AS ALTERNATIVE 3, BUT LEVEL III TREATMENT.............



VER
VO
SPRINGVILLE
ISH FORK

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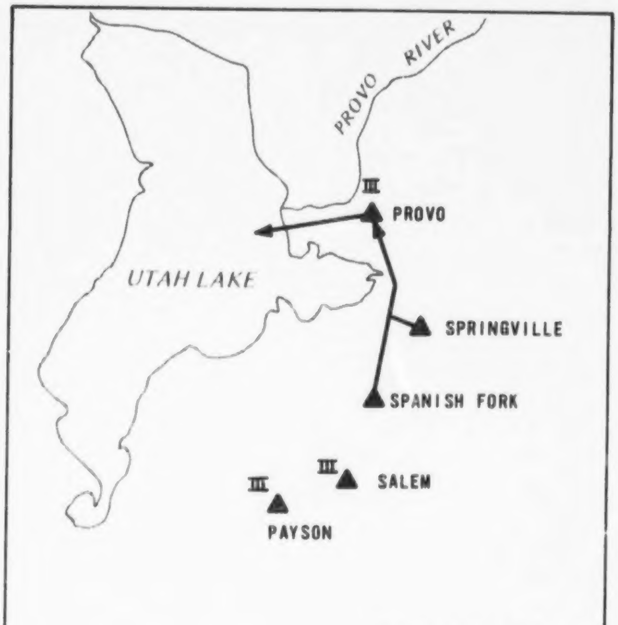
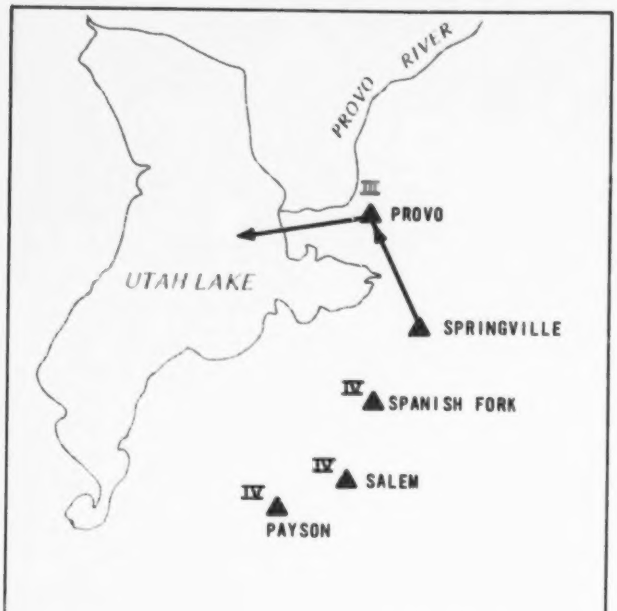
FIGURE 13-4
CENTRAL UTAH COUNTY
MUNICIPAL WASTEWATER
MANAGEMENT ALTERNATIVES

B


PROVO RIVER
III
PROVO
UTAH LAKE
SPRINGVILLE
SPANISH FORK
III
SALEM
III
PAYSON

ALTERNATIVE NO. 7

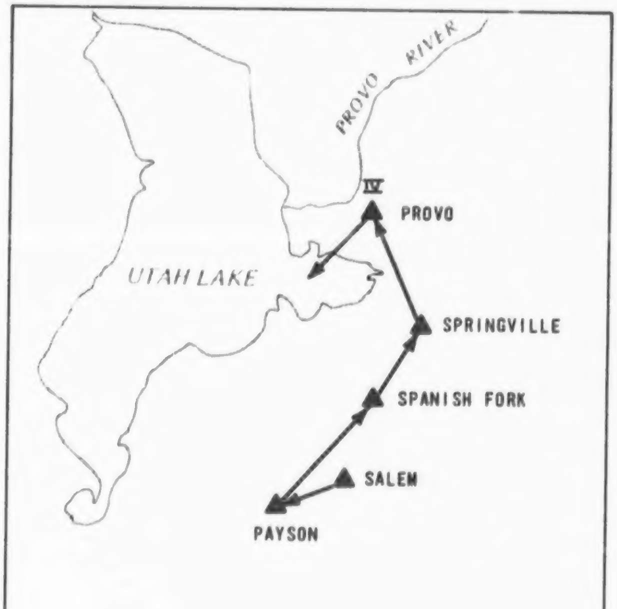
CONVEY FLOWS FROM SPANISH FORK AND SPRINGVILLE TO EXPANDED PROVO PLANT. LEVEL III TREATMENT, LAKE OUTFALL. SALEM AND PAYSON REMAIN AT PRESENT LOCATIONS WITH LEVEL III TREATMENT.


PROVO RIVER
III
PROVO
UTAH LAKE
SPRINGVILLE
IV
SPANISH FORK
IV
SALEM
IV
PAYSON

ALTERNATIVE NO. 8

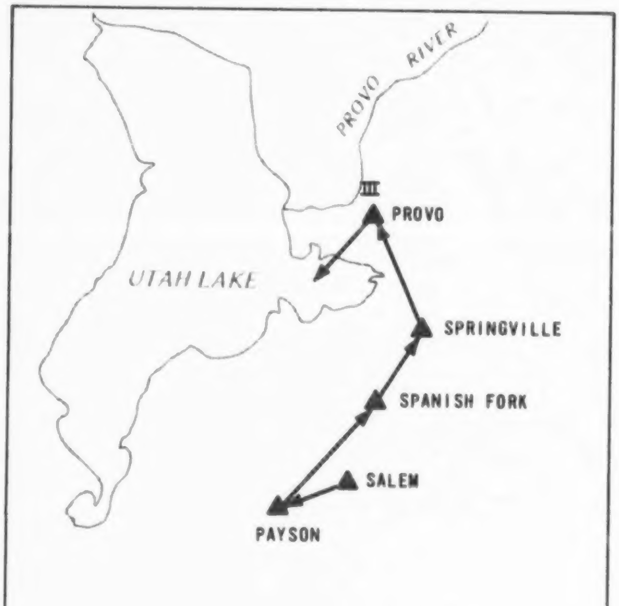
CONVEY FLOW FROM SPRINGVILLE TO PROVO; LEVEL III TREATMENT WITH LAKE OUTFALL. SPANISH FORK, PAYSON AND SALEM REMAIN SEPARATE. LEVEL IV TREATMENT.

AS ALTERNA
PLANTS.


PROVO RIVER
IV
PROVO
UTAH LAKE
SPRINGVILLE
SPANISH FORK
SALEM
PAYSON

ALTERNATIVE NO. 11

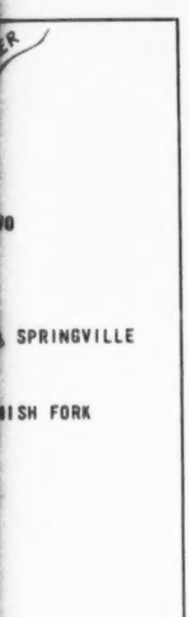
CONVEY FLOWS FROM SPANISH FORK, SPRINGVILLE, SALEM AND PAYSON TO EXPANDED PROVO PLANT. LEVEL IV TREATMENT; DISCHARGE TO PROVO BAY.


PROVO RIVER
III
PROVO
UTAH LAKE
SPRINGVILLE
SPANISH FORK
SALEM
PAYSON

ALTERNATIVE NO. 12

AS ALTERNATIVE 11, BUT LEVEL III TREATMENT.

A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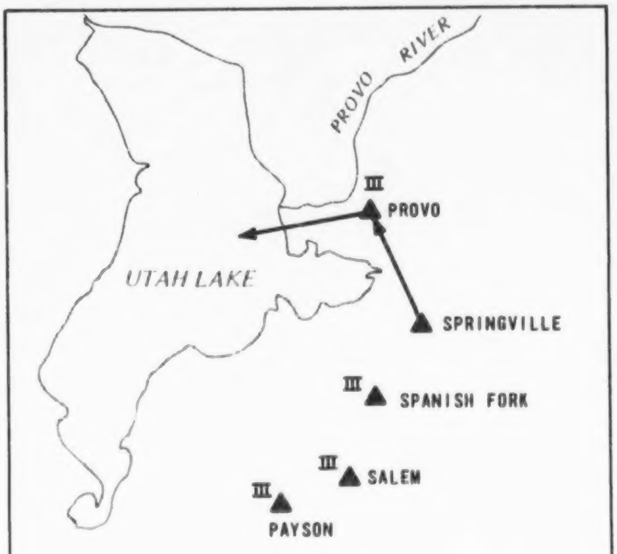
O
SPRINGVILLE
ISH FORK

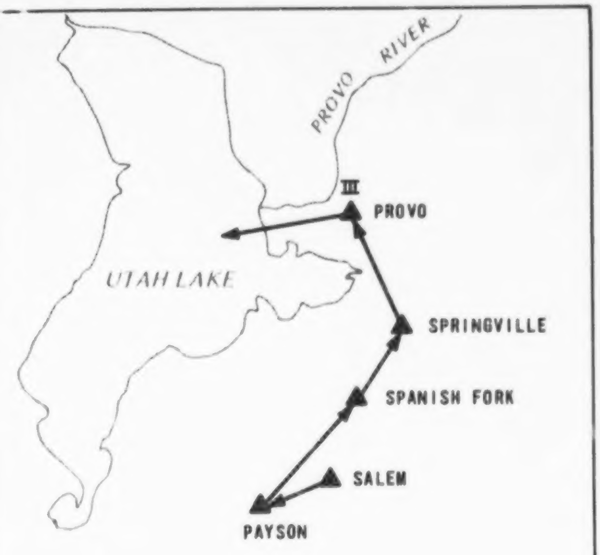
ERNATIVE NO. 8

O; LEVEL III
H FORK, PAYSON
TREATMENT


PROVO RIVER
III
PROVO
UTAH LAKE
SPRINGVILLE
III
SPANISH FORK
III
SALEM
III
PAYSON

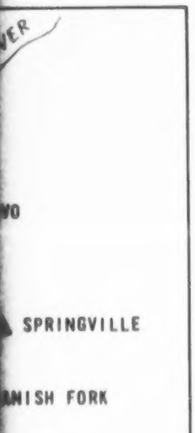
ALTERNATIVE NO. 9

AS ALTERNATIVE 8, BUT LEVEL III TREATMENT AT ALL PLANTS.


PROVO RIVER
III
PROVO
UTAH LAKE
SPRINGVILLE
SPANISH FORK
SALEM
PAYSON

ALTERNATIVE NO. 10

CONVEY FLOWS FROM SPANISH FORK, SPRINGVILLE, SALEM AND PAYSON TO EXPANDED PROVO PLANT. LEVEL III TREATMENT, LAKE OUTFALL.


ER
O
SPRINGVILLE
NISH FORK

NATIVE NO. 12

ATMENT

FIGURE 13-4 (Continued)
CENTRAL UTAH COUNTY
MUNICIPAL WASTEWATER
MANAGEMENT ALTERNATIVES

B

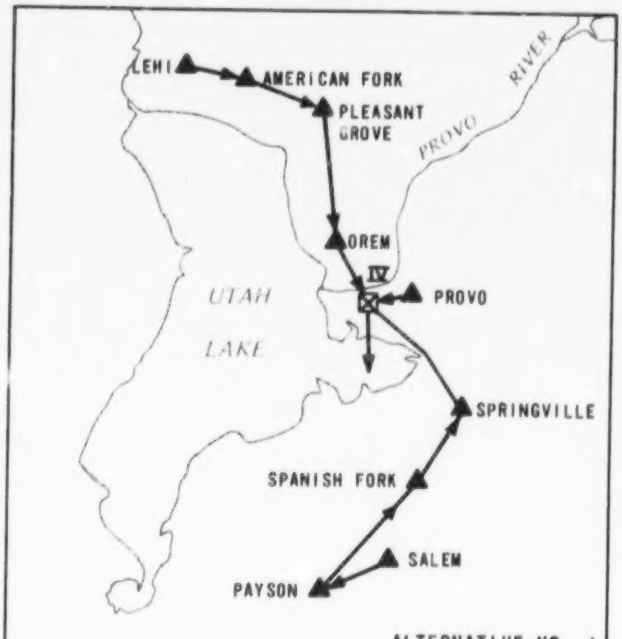
Alternative 1	Modify and expand existing plants at existing locations. Treatment level IV.
Alternative 2	As Alternative 1, but level III treatment.
Alternative 3	Modify and expand existing plants at existing locations. Convey flows from Salem to Payson. Treatment level IV.
Alternative 4	As Alternative 3, but level III treatment.
Alternative 5	Convey flows from Spanish Fork and Springville to expanded Provo plant. Salem and Payson plants remain at existing locations. Level IV treatment.
Alternative 6	As Alternative 5, but level III treatment.
Alternative 7	Convey flows from Spanish Fork and Springville to expanded Provo plant. Level III treatment, lake outfall. Salem and Payson remain at present locations with level III treatment.
Alternative 8	Convey flow from Springville to Provo; level III treatment with lake outfall. Spanish Fork, Payson and Salem remain separate. Level IV treatment.
Alternative 9	As Alternative 8, but level III treatment at all plants.
Alternative 10	Convey flows from Spanish Fork, Springville, Salem and Payson to expanded Provo plant. Level III treatment, lake outfall.
Alternative 11	Convey flows from Spanish Fork, Springville, Salem and Payson to expanded Provo plant. Level IV treatment; discharge to Provo Bay.
Alternative 12	As Alternative 11, but level III treatment.

Alternative Courses of Action--Utah and Wasatch Counties

In addition to the separate alternatives for Northern Utah County, Central Utah County and Wasatch County, several alternatives were considered that consolidate wastewater flows from these areas.

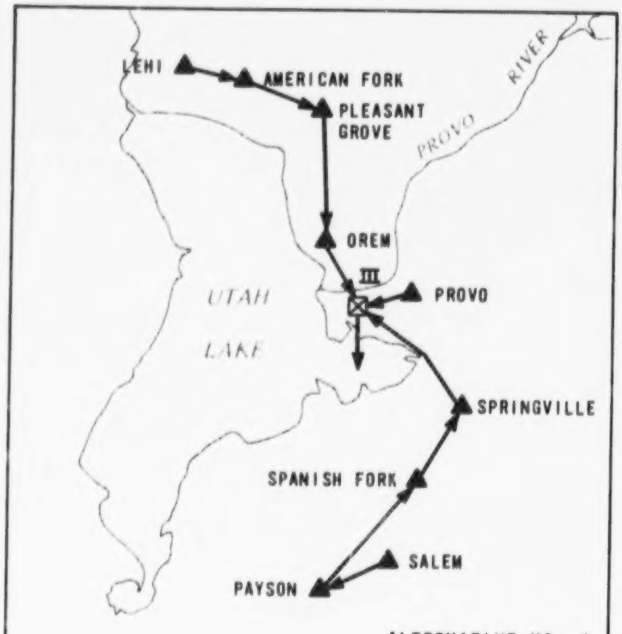
The alternatives considered are described below and illustrated in Figure 13-5.

Alternative 1	Convey all flows from Northern and Central Utah County to new regional plant near Provo. Level IV treatment and discharge to Provo Bay.


LEHI
AMERICAN FORK
PLEASANT GROVE
PROVO RIVER
OREM
IV
PROVO
UTAH LAKE
SPRINGVILLE
SPANISH FORK
SALEM
PAYSON

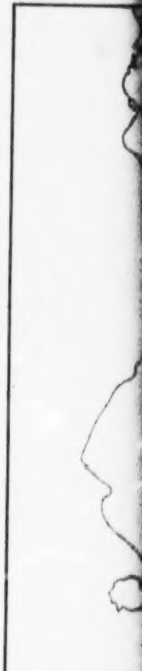
ALTERNATIVE NO. 1

CONVEY ALL FLOWS FROM NORTHERN AND CENTRAL UTAH COUNTY NEW REGIONAL PLANT NEAR PROVO. LEVEL IV TREATMENT AND DISCHARGE TO PROVO BAY

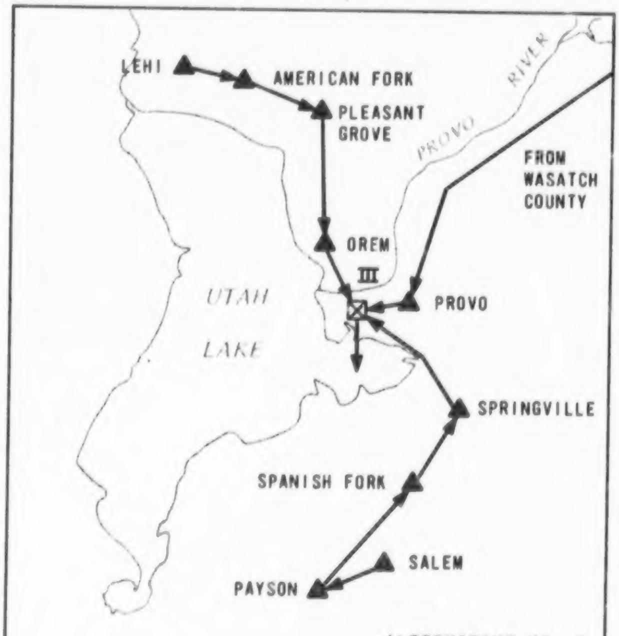

LEHI
AMERICAN FORK
PLEASANT GROVE
PROVO RIVER
OREM
III
PROVO
UTAH LAKE
SPRINGVILLE
SPANISH FORK
SALEM
PAYSON

ALTERNATIVE NO. 2

AS ALTERNATIVE 1, BUT WITH LEVEL III TREATMENT

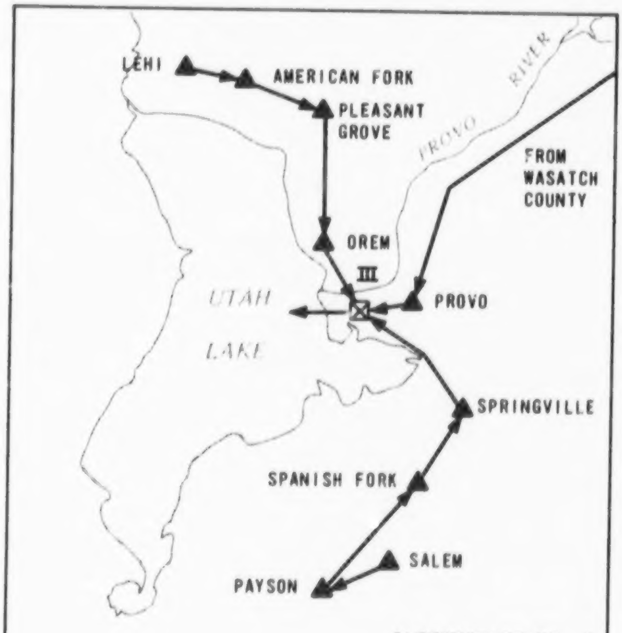


AS ALTERNA
CONSTRUCT


LEHI
AMERICAN FORK
PLEASANT GROVE
PROVO RIVER
FROM WASATCH COUNTY
OREM
III
PROVO
UTAH LAKE
SPRINGVILLE
SPANISH FORK
SALEM
PAYSON

ALTERNATIVE NO. 5

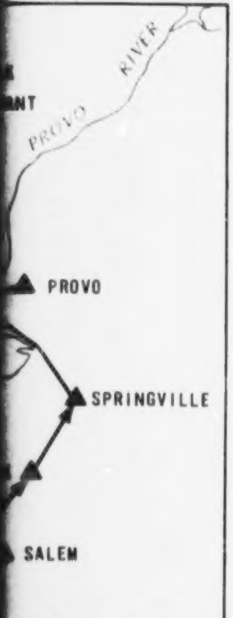
AS ALTERNATIVE 2, BUT INCLUDING ALL FLOWS FROM WASATCH COUNTY.


LEHI
AMERICAN FORK
PLEASANT GROVE
PROVO RIVER
FROM WASATCH COUNTY
OREM
III
PROVO
UTAH LAKE
SPRINGVILLE
SPANISH FORK
SALEM
PAYSON

ALTERNATIVE NO. 6

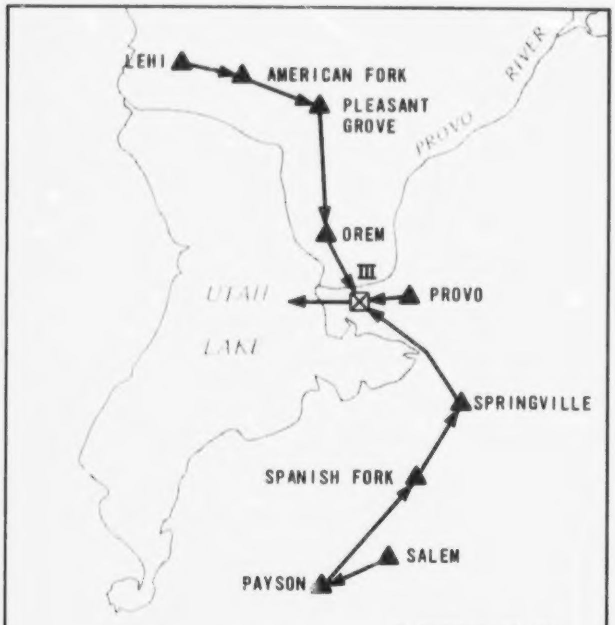
AS ALTERNATIVE 3, BUT INCLUDING ALL FLOWS FROM WASATCH COUNTY

A


RIVER
PROVO
PROVO
SPRINGVILLE
SALEM

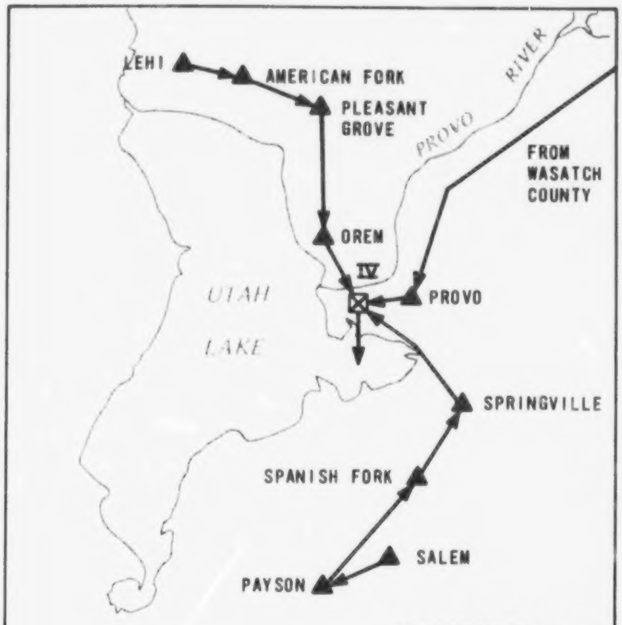
LTERNATIVE NO. 2

III TREATMENT


LEHI
AMERICAN FORK
PLEASANT GROVE
RIVER
PROVO
OREM
III
UTAH
LAKE
PROVO
SPRINGVILLE
SPANISH FORK
SALEM
PAYSON

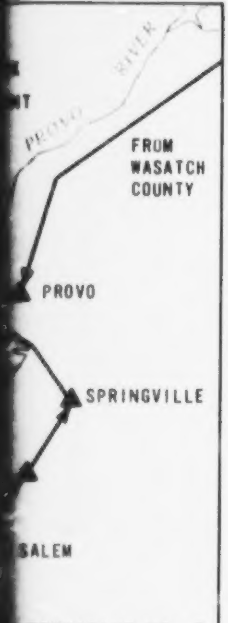
ALTERNATIVE NO. 3

AS ALTERNATIVE 1, BUT WITH LEVEL III TREATMENT CONSTRUCT OUTFALL TO UTAH LAKE.


LEHI
AMERICAN FORK
PLEASANT GROVE
RIVER
PROVO
FROM WASATCH COUNTY
OREM
IV
UTAH
LAKE
PROVO
SPRINGVILLE
SPANISH FORK
SALEM
PAYSON

ALTERNATIVE NO. 4

AS ALTERNATIVE 1, BUT INCLUDING ALL FLOWS FROM WASATCH COUNTY.


RIVER
PROVO
FROM WASATCH COUNTY
PROVO
SPRINGVILLE
SALEM

LTERNATIVE NO. 6

FLOWS FROM

FIGURE 13-5
OVERALL UTAH AND WASATCH COUNTY
MUNICIPAL WASTEWATER
MANAGEMENT ALTERNATIVES

B

Alternative 2 As Alternative 1, but with level III treatment.

Alternative 3 As Alternative 1, but with level III treatment. Construct outfall to Utah Lake.

Alternative 4 As Alternative 1, but including all flows from Wasatch County.

Alternative 5 As Alternative 2, but including all flows from Wasatch County.

Alternative 6 As Alternative 3, but including all flows from Wasatch County.

Alternative Courses of Action--Southern Utah and Northern Juab Counties

For the purposes of the study, this area is defined as Southern Utah and Northern Juab counties, including the communities of Santaquin, Goshen and Elberta and a small portion of Northern Juab County comprising the communities of Mona and Nephi. At the present time only Nephi collects and treats sewage using a lagoon system.

No alternative water quality management plans for the area have been developed for the following reasons. The communities are small, as are the wastewater flows generated. Conveyance of wastewater out of the area is clearly uneconomic.

The most appropriate course of action for the area is to continue to use septic tank systems wherever soil conditions permit. If health hazards or water quality problems become apparent, it may be necessary to construct collection and treatment facilities. This should be done only when it is clearly apparent that well-designed septic tank systems are ineffective. Nephi should continue to use its wastewater lagoons unless problems develop, in which case it may be necessary to construct more sophisticated treatment facilities.

Evaluation of Alternatives

Each alternative was evaluated by the study consultants as described in Chapter 12. The results of the evaluation are summarized in Tables 13-12, 13-13, and 13-14. Detailed evaluation matrices are included in Appendix 13-A. This material was included in a briefing document describing alternative courses of action for treatment and disposal of municipal

Tab'e 13-12

NORTHERN UTAH COUNTY - SUMMARY OF EVALUATION OF ALTERNATIVES[a]

Alternative	1	2	3	4	5	6	7	8	9	10[b]	11[b]	12[b]
Treatment Level	IV	III	III	III&IV	IV	III	III	III	III&IV	III	IV	III
Capital Cost	9.49	4.18	7.61	9.22	12.96	7.94	9.76	9.75	12.75	29.22	30.72	24.86
Annual Amortization Cost	0.76	0.33	0.57	0.72	0.96	0.61	0.74	0.72	0.93	2.21	2.38	1.89
Annual Operation and Maintenance Cost	1.39	0.93	0.92	1.30	1.18	0.79	0.79	0.58	0.88	1.24	1.80	1.22
Total Annual Cost	2.15	1.26	1.49	2.02	2.14	1.40	1.53	1.30	1.81	3.45	4.18	3.11
Subjective Ratings												
Environmental	245	214	254	235	278	230	268	268	273	280	290	259
Feasibility	218	228	219	218	199	209	192	183	173	138	137	138
Effectiveness	120	128	188	137	189	182	200	228	203	242	222	215

[a] All costs are expressed in millions of dollars.

[b] Includes Provo.

Table 13-13

CENTRAL UTAH COUNTY - SUMMARY OF EVALUATION OF ALTERNATIVES[a]

Alternative	1	2	3	4	5	6	7	8	9	10	11	12
Treatment Level	IV	III	IV	III	IV	III	III	III&IV	III	III	IV	III
Capital Cost	17.05	8.37	17.38	8.91	18.50	11.66	15.37	16.58	13.92	17.84	20.17	14.12
Annual Amortization Cost	2.30	0.67	1.37	0.70	1.45	0.90	1.18	1.26	1.05	1.35	1.56	1.07
Annual Operation and Maintenance Cost	1.36	1.53	2.28	1.52	1.91	1.39	1.43	1.65	1.42	1.01	1.50	0.97
Total Annual Cost	3.66	2.20	3.65	2.22	3.36	2.29	2.60	2.91	2.47	2.36	3.06	2.05
Subjective Ratings												
Environmental	245	214	245	221	271	230	257	271	252	299	309	273
Feasibility	200	228	191	219	173	192	166	175	184	139	146	165
Effectiveness	114	114	138	114	165	149	173	173	172	214	201	194

[a] All costs are expressed in millions of dollars.

Table 13-14

OVERALL UTAH AND WASATCH COUNTY MUNICIPAL WASTEWATER TREATMENT ALTERNATIVES[a]

Alternative	1	2	3	4[b]	5[b]	6[b]
Treatment Level	IV	III	III	IV	III	III
Capital Cost	42.03	34.17	38.71	51.41	43.24	47.79
Annual Amortization Cost	3.22	2.61	2.93	3.89	3.19	3.52
Annual Operation and Maintenance Cost	2.14	1.47	1.51	2.25	1.54	1.58
Total Annual Cost	5.36	4.08	4.44	6.14	4.73	5.10
Subjective Ratings						
Environmental	273	242	299	300	262	299
Feasibility	129	130	130	128	120	120
Effectiveness	185	178	205	178	171	198

[a] All costs are expressed in millions of dollars.

[b] Includes Wasatch County.

wastewaters and their costs. The document was mailed to concerned individuals and agencies in December 1973. A public meeting to discuss the alternatives was held in Utah County in January 1974. Local opinion did not appear to favor any particular alternative although some reluctance to alter present arrangements for sewage collection, treatment and disposal was expressed. During the latter part of January and February, representatives of the affected cities met to discuss the alternatives in detail and decide on a preferred course of action. The local entities expressed the view that the basin study cost estimates and projected wastewater flows were both too low. As a result, the entities and their engineers undertook an independent study which identified their preferred alternatives.

Analysis of Alternatives

Despite the differences in flow rates and cost estimates, the conclusions that can be drawn from the basin study and the local engineers' analyses are quite similar.

Considering the case of a level IV effluent, both analyses demonstrate that consolidation of treatment facilities at Orem offers the lowest total annual cost for the Northern Utah County area. If a level III effluent proves adequate, a similar configuration still appears to afford a slightly lower annual cost.

In Central Utah County both analyses indicate that if level IV treatment is required then consolidation of all flows at Provo results in the lowest total annual cost. If treatment level III is required, then both the analyses indicate that the same configuration is the most economical, with the possible exception of the area south of Spanish Fork.

Consideration of the overall alternatives that combine all county flows at Provo shows that in the case of the local engineers' estimates this alternative results in the lowest total annual cost. The original basin study estimates indicate that this option is slightly more expensive than regionalizing at two locations in Utah County, although when the local engineers' projected flows were used this option became slightly less expensive.

In Northern Utah County, the local engineers identified two preferred alternatives: regionalization of Lehi, Pleasant Grove and American Fork, with Orem separate, or else regionalization of all four communities at Orem. Comparing alternatives 6 and 8 and 5 and 9 with respect to the nonquantifiable factors, it is apparent that, while regionalization at Orem offers some advantages in terms of total annual cost, regionalization at American Fork, with Orem separate, offers better feasibility and somewhat lower capital cost. Thus the recommended plan for Northern Utah County is regionalization at American Fork with Orem separate. The option for regionalization at Orem will remain open as an acceptable alternative to the entities involved as they undertake a more detailed analysis in their facilities planning.

In Central Utah County, the local engineers identified regionalization at Provo as the preferred course of action. If level III treatment proves adequate, it is apparent from the total annual costs shown in Table 13-13 that the economic benefits of regionalization are marginal although other benefits such as plant reliability and management advantages are still afforded. If level IV treatment is necessary or the local engineers' estimates of future flows are more nearly correct, the argument for regionalization becomes much stronger. It should be noted that the engineers' projected flows are based on optimistically high estimates of population growth in that area. It is almost certain that Salem and possibly Payson will not need level IV treatment to meet the Class "C" stream standards. Hence, the implementation plan must be flexible enough to allow Salem and Payson to opt for nonregionalization should level IV treatment prove unnecessary or if primary/secondary expansion proves unnecessary after infiltration and inflow is reduced.

MUNICIPAL WASTEWATER MANAGEMENT ALTERNATIVES FOR WASATCH COUNTY

Development of municipal wastewater management alternatives for Wasatch County is problematical for several reasons. Many residential developments are being proposed for the area; however, doubts surround their acceptance, both by agencies responsible for planning and public health and by potential buyers. Estimates of future population are inevitably imprecise. The proposed Mayflower development near Hailstone Junction north of Heber City, for example, would, if fully implemented, more than double the population of the county.

Heber City and Midway are the only communities in Wasatch County that operate wastewater collection and treatment facilities. Heber City's collection system suffers from massive infiltration, making estimation of future wastewater flows extremely difficult.

In order to develop alternatives, a number of assumptions have been made and a singular approach adopted. Projected wastewater flows are based on conservative or minimal estimates of population increase. In addition, it has been assumed that the Heber City collection system can be rehabilitated and infiltration reduced to a more acceptable level.

Present and projected flows are shown in Table 13-15. Wasteload allocations are shown in Table 13-16.

All alternatives considered for Wasatch County that involve discharge of wastewaters to the surface waters upstream of Deer Creek Reservoir include treatment to remove plant nutrients. Since Deer Creek Reservoir is already plagued by nuisance algae during the late summer months, it seems desirable to reduce the input of nutrients to the reservoir. Further detailed study will be required to determine whether removal of nutrients from wastewaters significantly reduces the nutrient input to the reservoir. For the purposes of this study nutrient removal is assumed to be necessary upstream of the reservoir.

It was assumed that flows from Wallsburg will be collected and conveyed out of the county for treatment at Provo by means of the proposed Provo Canyon interceptor sewer.

Alternative Courses of Action

The most promising alternatives for Wasatch County are described below and illustrated in Figure 13-6.

Alternative 1	Modify existing plants at present locations, with treatment level IV at Heber and Midway plants. Discharge points as existing on Spring and Snake Creeks.
Alternative 2	Modify existing plants at present locations, with treatment level III at Heber and at Midway. Heber to construct outfall to Provo River; Midway to continue discharge at present site.
Alternative 3	Convey all sewage to new regional plant to be constructed near Charleston. Treatment level III with outfall to Provo River.

Table 13-15

PRESENT AND PROJECTED WASTEWATER FLOWS [a]
WASATCH COUNTY

Source	Present (1972)	1980	1995
Heber City	2.6	1.4	1.8
Midway City	0.2	0.3	0.4

[a] Assuming elevation of excessive infiltration and inflow to the collection system.

Table 13-16

MUNICIPAL WASTE LOAD ALLOCATIONS AND TREATMENT LEVELS [a]
WASATCH COUNTY

Source	Effluent Quality BOD, mg/l	Waste Load Alloc. BOD, lb/day	Required Treatment Level	Probability of Compliance with W.Q. Standards
Heber City	10	166	III	Good
Midway City	10	25	III	Good

[a] Assessment of the probability that application of the required treatment level will result in water quality standard compliance in the receiving waters.

Alternative 4	Construct Regional plant south of Heber with treatment level II followed by percolation basins.
Alternative 5	Construct regional plant south of Heber with treatment level IV; discharge to Provo River above Deer Creek Reservoir.
Alternative 6	Convey all municipal sewage out of the basin to an expanded Provo plant.

Evaluation of Alternatives

Each alternative was evaluated by the study consultants as described in Chapter 12. The results of the evaluation are summarized in Table 13-17. Detailed evaluation matrixes are included in Appendix 13-A. This material was included in a briefing document describing alternative courses of action for treatment and disposal of municipal wastewaters and their costs. The document was mailed to concerned individuals and agencies in December 1973. A public meeting to discuss the alternatives was held in Wasatch County in January 1974. Considerable reluctance to alter present arrangements for sewage collection, treatment and disposal was expressed.

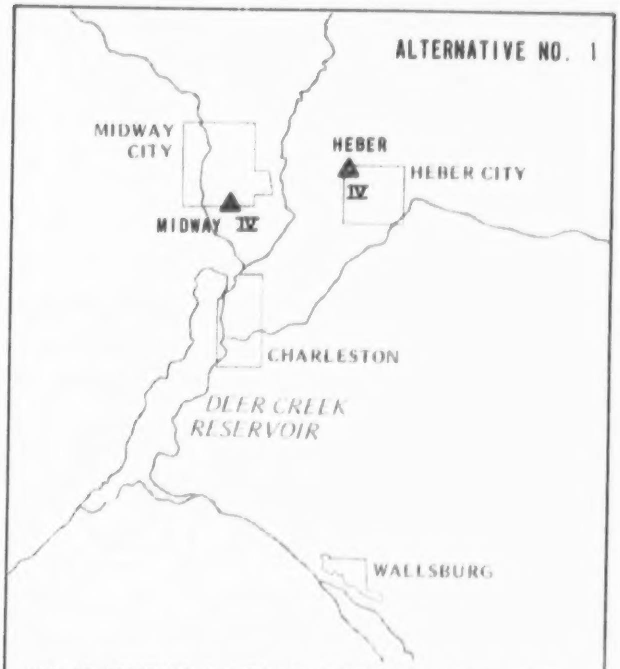
In early April a meeting was held between the State Division of Health, their consultants and the technical representatives of the sewage agencies involved. On further consideration of the available options, sentiment

Analysis of Alternatives

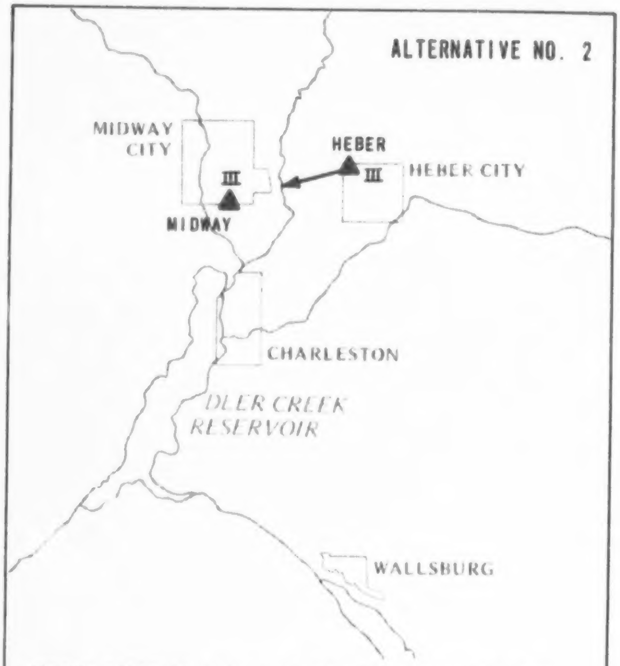
The Heber City plant is presently grossly overloaded; the Midway plant retains some spare capacity although insufficient to handle flows from all propcsed residential developments, and septic tank systems are giving rise to problems in many parts of the county.

In view of the foregoing, it is apparent that the best overall alternative for Wasatch County will necessarily be one that solves the immediate problems but retains the flexibility to handle future development.

If level III treatment is sufficient to meet water quality standards in Wasatch County, as appears likely, then the total annual costs of expanding and upgrading both existing plants, constructing a new regional plant or constructing a regional land disposal facility are quite close. Rejecting the latter alternative as marginally feasible, it would appear that

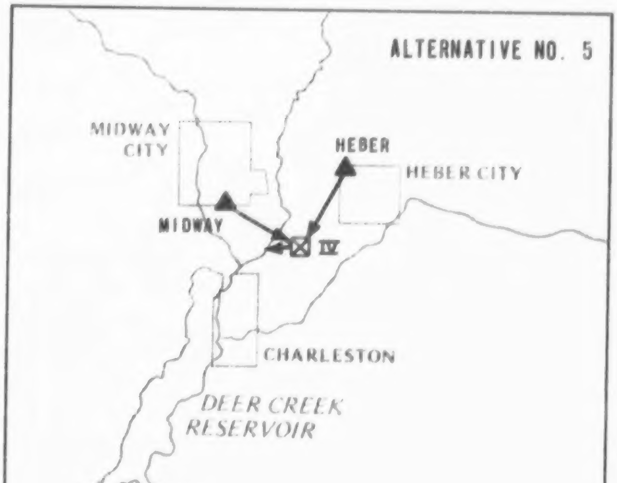

ALTERNATIVE NO. 1
MIDWAY CITY
HEBER
HEBER CITY
IV
MIDWAY IV
CHARLESTON
DEER CREEK RESERVOIR
WALLSBURG

MODIFY EXISTING PLANTS AT PRESENT LOCATIONS, WITH TREATMENT LEVEL IV AT HEBER AND MIDWAY PLANTS. DISCHARGE POINTS AS EXISTING ON SPRING AND SNAKE CREEKS.

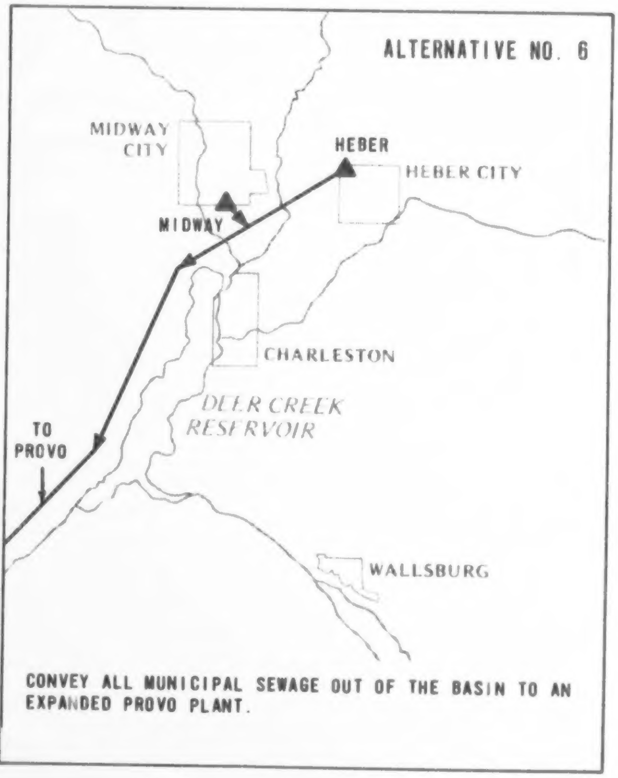

ALTERNATIVE NO. 2
MIDWAY CITY
III
MIDWAY
HEBER
III
HEBER CITY
CHARLESTON
DEER CREEK RESERVOIR
WALLSBURG

MODIFY EXISTING PLANTS AT PRESENT LOCATIONS WITH TREATMENT LEVEL III AT HEBER AND AT MIDWAY. HEBER TO CONSTRUCT OUTFALL TO PROVO RIVER; MIDWAY TO CONTINUE DISCHARGE AT PRESENT SITE.

CONVEY
CONSTRU
WITH OU

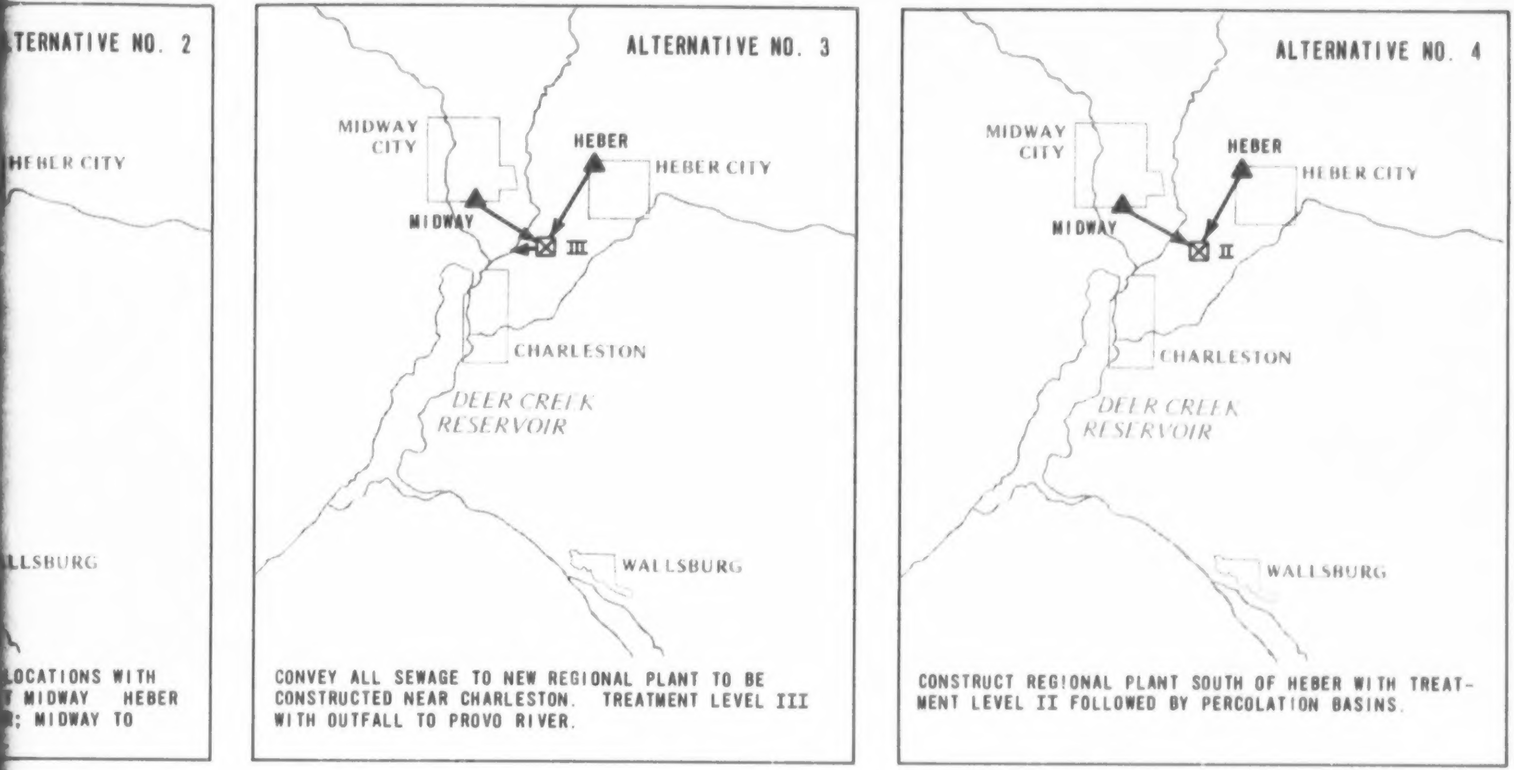

ALTERNATIVE NO. 5
MIDWAY CITY
HEBER
HEBER CITY
MIDWAY
IV
CHARLESTON
DEER CREEK RESERVOIR
WALLSBURG

CONSTRUCT REGIONAL PLANT SOUTH OF HEBER WITH TREATMENT LEVEL IV; DISCHARGE TO PROVO RIVER ABOVE DEER CREEK RESERVOIR.


ALTERNATIVE NO. 6
MIDWAY CITY
HEBER
HEBER CITY
MIDWAY
CHARLESTON
DEER CREEK RESERVOIR
TO PROVO
WALLSBURG

CONVEY ALL MUNICIPAL SEWAGE OUT OF THE BASIN TO AN EXPANDED PROVO PLANT.

A


TERNATIVE NO. 2
HEBER CITY
LLSBURG
ALTERNATIVE NO. 3
MIDWAY CITY
HEBER
HEBER CITY
MIDWAY
III
CHARLESTON
DEER CREEK RESERVOIR
WALLSBURG
ALTERNATIVE NO. 4
MIDWAY CITY
HEBER
HEBER CITY
MIDWAY
II
CHARLESTON
DEER CREEK RESERVOIR
WALLSBURG

LOCATIONS WITH
MIDWAY HEBER
; MIDWAY TO

CONVEY ALL SEWAGE TO NEW REGIONAL PLANT TO BE CONSTRUCTED NEAR CHARLESTON. TREATMENT LEVEL III WITH OUTFALL TO PROVO RIVER.

CONSTRUCT REGIONAL PLANT SOUTH OF HEBER WITH TREATMENT LEVEL II FOLLOWED BY PERCOLATION BASINS.

TERNATIVE NO. 6
HEBER CITY
LSBURG

THE BASIN TO AN

FIGURE 13-6
WASATCH COUNTY
MUNICIPAL WASTEWATER
MANAGEMENT ALTERNATIVES

B

Table 13-17

WASATCH COUNTY - SUMMARY OF EVALUATION OF ALTERNATIVES[a]

Alternative	1	2	3	4	5	6
Treatment Level	IV	III	III	II	IV	IV
Capital Cost	3.67	2.49	3.83	2.77	5.14	10.30
Annual Amortization Cost	0.29	0.19	0.30	0.22	0.40	0.74
Annual Operation and Maintenance Cost	0.39	0.26	0.21	0.16	0.32	0.18
Total Annual Cost	0.68	0.45	0.51	0.38	0.72	0.92
Subjective Ratings						
Environmental	264	245	263	243	311	330
Feasibility	182	192	156	148	129	85
Effectiveness	126	140	172	166	218	177

[a] All costs are expressed in millions of dollars.

of the two remaining options regionalization offers several advantages. The new plant could be constructed near Charleston at an elevation that would allow gravity conveyance from most parts of the county. The new, larger plant could produce a more consistent effluent quality than the upgraded existing facilities. In addition, a regional system could respond more flexibly to demographic changes. Another factor that may increase the advantages of regionalization is the possible interactability of the Heber City infiltration problem which may further vitiate the existing treatment facility. Thus, Alternative 3, regionalization near Charleston, appears to be the best for the area.

Alternative 6, conveyance of all waste out of Heber Valley via an expanded Provo Canyon sewer is more expensive than the other options considered; however, it does offer the benefit of eliminating municipal wastewater discharges from a water supply catchment. As a consequence, this alternative is retained as an acceptable, although unlikely, option for the county.

ALTERNATIVE INSTITUTIONAL ARRANGEMENTS FOR WASTEWATER MANAGEMENT

The institutional arrangements for control of water quality are usually centered on a special purpose district agency which has very limited powers to implement controls other than waste collection and treatment. Because many of man's activities impact upon water quality an agency responsible for it's control, would ideally have the power to regulate all of these activities. In reality, however, this is rarely possible although examples do exist of institutional arrangements which go some way toward the ideal.

Although some consolidation of wastewater treatment facilities has already occured in the study area, further regionalization will require changes in the present institutional arrangements for sewage collection, treatment and disposal. Thus, it is useful to review experiences outside the Salt Lake-Provo metropolitan area. In other areas, a number of governmental and financing arrangements have achieved success in implementing regional water quality control programs in areas formerly containing fragmented patterns of local government structure and dispersed responsibilities and controls for water quality control activities. At one extreme are devices such as voluntary service contracts among public entities that do not alter the basic structure of functional responsibilities of the entities. And the other extreme are public financing and governmental mechanisms that have changed local government structure, transferred functional responsibilities among existing public entities and consolidated existing entities into new multi-purpose or single-purpose regional entities.

Several different public financing mechanisms have been successful in implementing regional water quality control programs. In the San Diego and Los Angeles metropolitan areas, the approach is one of cooperative action through agreements among existing public entities. In the Seattle and Toronto metropolitan areas, local government organization was reshaped by creating a two-level federated structure in which responsibility for service was shared; however, the former was established by voters as a single-purpose entity while the latter was established as a multi-purpose entity and subsequently expanded by the provincial legislature.

Despite differences in approach, these mechanisms are not mutually exclusive. They have common features which will provide the following helpful guides in formulating a public governmental and financing mechanism to implement a Salt Lake-Provo Metropolitan Area regional water quality control plan:

1. Governmental and financing mechanisms which have been developed to handle water quality control problems in metropolitan areas tend to be single-purpose rather than multi-purpose.

2. Responsibility for areawide planning and program development is centralized in one entity which is usually empowered to develop a comprehensive plan and implement it through adoption and enforcement of rules and regulations; the financing, construction and operation of

facilities; and the apportionment and collection of costs from benefitted entities.

3. The entity having responsibility for implementing the plan usually issues bonds to finance capital facilities. Bonds are secured by long-term contracts that obligate benefitted entities to meet capital and operating costs based on capacity rights purchased and measured flows into the metroplitan system. Of special significance is the Toronto mechanism which uses the credit base of the entire metropolitan area to secure bonds to finance both metropolitan and local facilities.

4. All entities studied provide means to protect and represent local interests through: (a) contractural provisions for the resolution or arbitration of disputes, (b) ex-officio membership of locally selected officials on metropolitan councils, (c) retention of local public entities and their responsibility to provide local service or (d) allowing local entities the option to choose the manner in which to meet their financial obligations from vailable revenue sources.

It is impossible to prescribe a workable regional mechanism to fit all situations. Factors peculiar to the Salt Lake Metropolitan Area will strongly influence the form and content of the governmental and financing mechanism best suited to implement a water quality management plan in the region; however, the experience of other areas in implementing regional or areawide water quality control plans will provide valuable guidance in formulating a public mechanism for the Salt Lake region. Of the various mechanisms that have proved reasonably successful, the ones employed by the following entities are discussed and presented at conceptual alternatives for the study area. San Diego Metropolitan Sewerage System, County Sanitation Districts of Los Angeles, Municipality of Metropolitan Seattle, Delaware River Basin Commission, Muskegon County, Michigan, East Bay Municipal Utility District, and the Municipality of Metropolitan Toronto.

San Diego Metropolitan Sewerage System

The San Diego Metropolitan Sewerage System, with future planned expansions and additions, is designed to serve a 410-square mile region with a projected population of 2.6 million by the year 2000. The system's initial stage, consisting of interceptor sewers, a major primary treatment plant and an ocean outfall, was financed by the City of San Diego with $6 million of available funds and the sale of $42.5 million City of San Diego sewer revenue bonds maturing in a 40-year period. Completed in 1963, the initial stage serves the City of San Diego, six adjacent cities and four county sanitation districts. Based on estimated population serviced by the system after its completion, capital costs approximated $63 per capita. Annual per capita costs for debt service, maintenance and operation are about $6. An important aspect of the San Diego System is that it includes, on a voluntary basis, all communities in the San Diego Bay drainage area. The system has thus achieved complete removal of waste effluents from San Diego Bay with notable improvement in bay water quality and the levels of recreational use.

Sewage Disposal Agreements Voluntary 40-year joint-exercise-of-powers agreements between the City of San Diego and participating public entities served as the basis for forming, constructing and operating the metropolitan system. The system, owned and operated by the City of San Diego, is used by participating entities to transmit, treat and dispose of their sewage.

Participating local entities, however, control and retain responsibility for their respective local sewage collection facilities.

The City of San Diego's $42.5 million sewer revenue bonds, secured by these agreements, obligate participating local entities to pay: (1) an annual fixed charge for a specific capacity right based on its estimated ultimate requirements; (2) a proportionate share of operation and maintenance costs measured by flow into the system; and, (3) a proportionate share of sewage transportation costs through jointly-used facilities. Each participating local entity may meet its obligation from any permissible source of funds, including property taxes, sewer service charges, connection fees or other special charges.

Capital Cost Allocations Planned system capacity is based on ultimate population and related sewage flow estimates for the region's drainage basin. The City of San Diego holds all reserve capacity in the system to meet unanticipated increased capacity needs of present participants and possible new participants. Each participating entity's charge for capacity rights is a fixed annual amount sufficient to meet its proportionate share of total capacity costs, interest on debts and incidental costs. Additional capacity rights may be assigned to a participating entity from reserve capacity if the system does not become unbalanced to the detriment of others. A participating entity's annual capacity charge is correspondingly increased for additional capacity rights it receives. New entities may join the system after all participants have been notified and the City of San Diego determines the system can meet their needs. A new participant's capacity right charge is based on the share of total system capacity it purchases plus a surcharge, based on computed costs, to compensate participants for expenses incurred from the start of the system.

Sanitation Districts of Los Angeles County

Critical sewage disposal problems in rapidly growing metropolitan areas of Los Angeles County during the 1920's led to the passage of legislation in 1923 permitting the formation of county sanitation districts. Such districts are empowered to: (1) acquire, build, and operate sewerage facilities, (2) contract for joint acquisition, construction or administration of sewerage facilities, (3) collect fees and charges for services rendered, (4) issue general obligation bonds, without limitation, secured by property taxes or other revenues, (5) issue revenue bonds secured by revenues produced from its facilities and (6) levy property taxes, without statutory limit as to rate or amount, for the maintenance and operation of facilities, payment of debt service and/or the acquisition or construction of new facilities.

Nine county sanitation districts in Los Angeles County were formed by 1930. Four districts connected to the City of Los Angeles sewage treatment plant while the others established and operated a separate joint sewerage system. The success of integrated facilities built in the late 1920's and 1930's established a strong tradition of cooperative action by county sanitation districts in Los Angeles County. By 1968, a total of 26 county sanitation districts had been formed, of which 15 were integrated into a joint outfall sewerage system serving an area of approximately 700 square miles with a population of four million. These 26 districts encompass 71 cities and numerous unincorporated areas. Jointly owned facilities include a truck sewer system and a primary sewage treatment plant with an average daily flow of 350 mgd and a peak flow capacity of 620 mgd, and an ocean outfall.

Five small secondary sewage treatment plants of individual districts, engaged in pioneering wastewater reclamation and underground aquifer recharging activities, complete the integrated system.

Joint Administration Agreements--All 26 county sanitation districts in Los Angeles County participate in an agreement which empowers county Sanitation District No. 2 to manage and administer the individual and collective business of the districts. The agreement provides that all costs which can be charged to a district for whose sole benefit the costs were incurred are to be paid by the benefitted district. All other administrative costs are shared among participants based on their respective share of total capital investment in the integrated sewerage system. All records and accounts are available to each participant. In the event of any disagreement an arbitration board is appointed to make findings of fact and binding rulings upon participating districts.

Joint Outfall Agreements--Fifteen county sanitation districts participate in a joint-outfall agreement. The planned joint-outfall system, designed to service the area until 2005, includes main and trunk sewers, pumping plants, and five secondary sewage treatment plants having a daily average flow of nearly 400 mgd. Treatment plants, interconnecting sewers and pumping plants are considered as one unit; however, individual districts are responsible for construction and maintenance of local facilities to connect into the joint-outfall system. Methods used to finance local facilities are let to local option, although most local facilities have been financed by a combination of bond funds and improvement funds on hand.

Joint-outfall system facilities have been financed principally by annual capital contributions from participating districts. County Sanitation District No. 2 is empowered to act on behalf of the districts to acquire lands and rights-of-way, pay all capital costs, and meet maintenance and operation costs. Capacity rights in a joint-outfall system facility are purchased by each district it serves. Capital costs are met by annual contributions from each district based on its share of total capacity rights. Rights to the capacity obtained are perpetual; however, they may be purchased or sold between districts or to new districts at their original cost.

Maintenance and operation costs of the joint-outfall system are apportioned among participants based on measured sewage flow into the system.

Municipality of Metropolitan Seattle

Severe public service problems resulting from a fragmented local government structure in the Seattle metropolitan area led to the passage of legislation in 1957 permitting the formation of multipurpose municipal corporations to provide comprehensive planning, sewage disposal, public transportation, water supply, garbage disposal and/or park services on a metropolitan or regional basis. A 1957 proposal to establish a municipal corporation to provide sewage disposal, public transportation and comprehensive planning services failed to receive the required concurrent voter majorities inside and outside the City of Seattle; however, a 1958 proposal for an entity to perform sewage disposal services alone in metropolitan Seattle was approved.

The Municipality of Metropolitan Seattle (METRO) serves an area of approximately 240 square miles and 800,000 population. Its boundaries lie in King County and contain 31 cities and special districts.

The enabling act provides for a federated government organization wherein constituent public entities are represented on the Metropolitan Council, on the basis of population, directly or through a member representing several smaller entities. The Council of 20 includes 19 ex-officio members who are mayors, councilmen or county supervisors. The remaining member, who serves as chairman and can hold no other public office, is selected by the 19 ex-officio members.

With its establishment, the Municipality acquired all local trunk sewers and treatment plant service areas over 1,000 acres. Revenue bond proceeds of $12 million were used to pay for acquired facilities on the basis of a 30-year retirement of regional costs. Constituent entities retained repsonsibility for facilities serving areas under 1,000 acres.

Since 1958, facilities worth over $234 million have been financed exclusively from the sale of revenue bonds maturing over 40 years. Major outfall and sewage treatment works, sized to estimated 20-year capacity needs, were completed in 1962 and 1964, respectively.

Special Powers--To provide metropolitan sewage disposal service, the Municipality is empowered to: (1) prepare a comprehensive metropolitan sewage disposal and storm water drainage plan, (2) acquire facilities within or beyond its jurisdictional area, or share in the use of a constituent entity's facilities on a contractual basis, (3) require constituent entities to connect local systems to the metropolitan system, (4) construct, lease, maintain, operate and improve sewerage facilities and establish rates and charges for their use and (5) establish minimum standards for constituent entity facilities and approve plans for their construction.

Financing Powers--The Municipality may issue general obligation bonds in an amount up to five percent of its taxable property valuation upon approval by 60 percent of the voters at a special election in which voter turn-out is at least 40 percent of that of the last preceding State general election. Principal and interest on general obligation bonds may be paid from property taxes, without limit as to rate or amount, and/or other unpledged revenues.

Revenue bonds may also be issued by the Municipality without voter approval. Funds from facilities financed by revenue bonds secure these bonds. All capital financing by the Municipality to date has been done with revenue bonds.

Sewage Disposal Agreements--Long-term agreements for 50 years between the Municipality and its component entities secure the Municipality's revenue bonds and require constituent entities to deliver all wastes to the metropolitan system at specified connection points from local facilities operated and maintained to standards set by the Municipality.

For Metropolitan sewage disposal service, each entity pays a charge, based on the number of its residential customer equivalents, calculated to meet the Municipality's annual costs of (1) maintenance, administration and operation, (2) revenue bond debt service and (3) reserves for working capital and facility replacement. The charge per residential equivalent, based on monthly water consumption of 900 cubic feet of water is $2.00 per month. Based on 1967 expenses of $2 million and $6 million for Municipality operations and debt service, respectively, the per capita cost for metropolitan sewage disposal service was approximately $10, excluding charges levied by constituent entities for local sewage collection and transmission services.

The Municipality may also levy special charges for handling sewage of unusual quality or composition, or volumes of storm and infiltrated water from local sewer systems which exceed the Municipality's minimum standards.

Delaware River Basin Commission

Severe hurricanes and floods in 1955 aroused public concern and created intense interest in cooperative state action to manage water resources of the Delaware River Basin. These efforts culminated in the adoption by Congress in 1971 of an interstate compact which created the Delaware River Basin Commission.

Special Powers--The Commission, composed of the United States Secretary of the Interior and the Governors of New York, Pennsylvania, Delaware and New Jersey, is reponsible for formulating and implementing a comprehensive water resources development plan for the basin. It is empowered to construct and operate facilities to develop water supply, control potential water pollution conditions and abate existing water pollution, classify basin waters and establish sewage and industrial waste treatment standards, issue orders after investigations and hearings, to public and private dischargers to cease discharges that violate Commission regulations and standards, invoke as complainant the powers and jurisdiction of its states' water pollution abatement agencies, and regulate flows, diversions, and withdrawals of basin waters to preserve water quality and abate existing pollution.

Comprehensive Planning Functions--With the responsibility to optimize development, conservation and management of the basin's water resources, the Commission has developed a plan which includes needed Federal and State reservoirs, watershed development projects, public sewage treatment works, public and private water supply facilities, and industrial waste disposal facilities. The plan's legal protection has also been extended to groundwater supplies to prevent depletion or contamination of underground sources. Also, the Commission has set primary treatment of all water discharges as the minimum standard throughout the basin. All plans for public or private water-related facilities are subject to review and approval by the Commission.

Financing Capital Facilities--Commission involvement in financing capital facilities has been confined to non-federal water supply capacity in three Federal Multipurpose reservoir projects. Repayment of funds, advanced interest-free by the Federal government for a period of up to ten years, for construction of water supply capacity must begin when the project is first used for water storage or supply purposes. To meet its obligations, the Commission has adopted the following principles:

1. The Commission will acquire and control the use of water supply capacity in Federal reservoir projects;
2. Subject to authorization by its member states, the Commission will repay first-instance capital loaned by the Federal government through annual State capital budget appropriations and revenues from the sale of water, products, or other services;

3. The Commission will determine benefits of reservoir water supply facilities and apportion to each benefiting State its share of costs in proportion to population served, and volume of waste discharges handled by reservoir-augmented stream flows.

The Commission is empowered to issue revenue bonds to finance capital facilities; however, it has elected to meet its first-instance capital advance interest and principal repayment obligations through annual capital budget appropriations. Payment of interest will begin in 1980 and first payments of principal for the repayment of capital will begin in 1990. The cost of providing 450,000 acre-feet of water supply in the three reservoirs, some $47.8 million, will be paid by annual appropriations averaging $1,346,000 and $558,000 by the States of Pennsylvania and New Jersey, respectively.

Muskegon County, Michigan

Situated on the eastern show of Lake Michigan, Muskegon County Wastewater Management System serves seven cities and six townships. The Board of Commissioners of Muskegon County created the system to (1) protect the quality of water resources, (2) provide for the existing and future needs for water and (3) extend recreational opportunities and agricultural, industrial and commercial development through the economic stimulation provided through assurance of water supply and quality.

Sewage Disposal Agreements--The Wastewater Management System collects, transports, treats and provides for disposal of municipal and industrial wastewater. The system is designed for 1992 conditions projected for the County (i.e., population: 170,000; municipal flow: 20 mgd; industrial flow: 24 mgd. and farmland acreage for final effluent disposal: 6,000 acres).

Financing of Facilities--General obligation bonds, issued by the County of Muskegon, have been used to finance capital expenditures. Although these bonds are secured by ad-valorem taxes, principal and interest payments are primarily met from revenue derived under contracts with the 13 entities (cities and townships) using the system. The individual entities have agreed to pay their proportionate shares of the periodic payments from their revenues and to levy advalorem taxes where revenues are insufficient to meet their shares of payments.

East Bay Municipal Utility District

The East Bay Municipal Utility District was created by popular vote in 1923--originally to supply water-- to serve a 277 square-mile area in Alameda and Contra Costa counties in northern California. In 1970, the District was supplying water to 1.1 million people in 15 communities and other unincorporated areas. Sewerage responsibilities were added to the scope of the District in 1944 through the formation of Special District No. 1.

Method of Financing--The District is authorized to incur indebtedness to a maximum limit of 20 percent of assessed value of land within the District. In 1974 the property tax rate was:

	Cents per $100 Property Value	
	Water	Sewerage
Alameda County	14.8	6.3
Contra-Costa County	15.4	6.6

Although tax-supported general obligation bonds comprise the primary source of financing revenues from sewer charges also be used to reduce debts.

Municipality of Metropolitan Toronto

Following World War II critical public service problems in the Toronto metropolitan area resulted from extensive suburban development, an enormous backlog of needed capital facilities postponed by the Depression and World War II, and abandonment by the City of Toronto of its traditional policy of annexing urbanized fringe areas. Solutions to these problems were submitted to the Ontario Municipal Board, a provincial agency responsible for promoting sound municipal development and having jurisdiction over all questions regarding municipal boundary revision, constitution and dissolution. On the basis of its own studies, the Board's solution, adopted by the provincial legislature effective January 1, 1954, established a federated government consisting of a metropolitan-multipurpose entity and 13 area municipalities.

While responsibility for many public services was retained by area municipalities, the Municipality was allocated responsibility for metropolitan water supply, sewage disposal, public transit, property assessment, public housing, and road construction and maintenance. In 1957 air pollution control, law enforcement, and civil defense were added to the Municipality responsibilities. In 1966 the Municipality was reorganized by consolidating the 13 area municipalities into six, adding school, library, welfare, and urban redevelopment services to the Municipality's responsibilities, and enlarging the metropolitan council from 25 to 33 members to afford suburban municipalities greater representation.

The Municipality's record of abating sewage disposal problems in the metropolitan area is formidable. Its program included the prohibition of all septic tanks, the discontinuance of inadequate area municipality sewage treatment plants, assumption of responsibility for constructing and maintaining major trunk and interceptor sewers, and construction of four major treatment plant having a combined capacity of 360 mgd. More than $100 million or about $65 per capita, was expended for regional sewerage facilities and present annual costs for maintenance, operation and debt service is approximately $9 per capita.

Special Powers--To meet its responsibilities for providing metropolitan sewerage services, the Municipality is empowered to construct, maintain, repair and improve sewerage facilities, establish regulations and standards governing the design, construction and maintenance of local sewerage works, regulate all connections to, and discharges into the metropolitan system, impose and collect from any area municipality, subject to the approval of the Ontario Municipal Board, a service charge to meet annual costs of maintenance and operation of metropolitan works, levy special charges on area municipalities for special benefits connected with the construction or operation of a sewerage facility, and inspect all area municipality sewerage works to determine compliance with municipality standards and regulations.

In disputes, the Ontario Municipal Board is empowered to hear complaints and make rulings if an area municipality considers itself damaged by the Municipality's failure to assume any local work as a metropolitan facility, receive waste or land drainage from the area municipality, approve construction, extension, improvements or alteration of local facilities or permit the connection or discontinuance of a connection to any metropolitan facility.

Financing Capital Facilities--With its formation in 1954, the Municipality assumed control over all sewage treatment works and trunk sewers in the metropolitan area. The Municipality at that time became responsible for all debt service on bonds issued by area municipalities for facilities incorporated into the metropolitan system.

With the Municipality's formation, all area municipalities were prohibited from issuing bonds for any purposes. Thereafter, the Municipality was empowered to issue bonds or notes, subject to the approval of the Ontario Municipal Board, for its own purposes as well as those of any area municipality or any board of education. All Municipality bonds are direct obligations of the Municipality and its area municipalities despite the fact that all or part of the funds to secure them may come from only one or several area municipalities. The incurrence of debt by the Municipality is thus based on pooling the entire financial base of the metropolitan area to secure its bonds.

The Metropolitan Council is required to adopt an annual budget for metropolitan sewerage service including costs of operations and maintenance, debt service on Municipality and area municipality sewer bonds, and establishing and maintaining sinking funds. The Council may apply a special levy for debt service or operating costs against an area municipality for special benefits received from a specific sewerage facility. The remaining costs which cannot be levied against specific area municipalities are apportioned among all area municipalities on the basis of each area municipality's ratio of assessed property to the Municipality's total assessed property. All levies against area municipalities for metropolitan services are considered taxes and a debt of the area municipalities to the Municipality. Property taxes, sewer service charges or other unpledged revenues may be used by an area municipality to meet its levy.

Coordination of Capital Facility Development--Of special interest is the Ontario Municipal Board's responsibility to ensure economic stability and orderly municipal growth. All municipalities, prior to making any capital expenditure requiring the incurrence of capital debt, must file detailed data to aid the Board to determine a municipality's capacity to assume additional debt and the impact on its taxpayers.

Regarding the actual incurrence of debt by a municipality, the Board may approve or disapprove the incurrence of any debt by a municipality, certify the validity of all municipal bonds, require a municipality to secure voter authorization of the bonds, dispense with any provisions of law that voters authorize bonds before their issuance after considering objections at a public hearing, inquire into all affairs of a municipality to protect its taxpayers and creditors and prevent default in meeting its obligations, and approve all sewer service charges proposed by a municipality to either meet its obligations or provide sewage disposal service to another municipality. Finally, the Board may set any conditions and restrictions on the issuance of bonds by a municipality which it feels necessary to ensure orderly development and economic stability.

CHAPTER 14

THE RECOMMENDED PLAN

Earlier chapters describe the natural and cultural factors affecting water quality, water quality goals and objectives and alternative means of attaining those goals. In this chapter, recommendations are made with respect to the necessary facilities and institutional arrangements and the means of surveillance and enforcement. Prior to the detailed descriptions, a recommended overall water quality management strategy is outlined.

RECOMMENDED OVERALL WATER QUALITY MANAGEMENT STRATEGY

If the beneficial use of many of the study area's streams is to be enhanced, then it is imperative that all streams not naturally ephemeral should be maintained at a flow rate that is sufficient to sustain a balanced flora and fauna. The pollution control measures described in this chapter will in many cases prove ineffective in restoring high levels of water quality and suitable aquatic environment, unless minimum flows are maintained. High priority must be given to an investigation of non-ephemeral streams subject to diversions on a case-by-case basis in order that minimum flow rates can be established that will support a balanced flora and fauna. The established water requirement should then be regarded as a prior water right owned by the people of the state and not subject to diversion by individuals or private companies.

The analyses performed as part of this study indicate that control of point sources of pollution, together with some straight-forward and common sense non-point source control measures, will significantly upgrade water quality. Major investment in non-point source controls should be deferred until the results of implementation of the provisions of the Federal Water Pollution Control Act, as amended in 1972, become apparent. Thus, the emphasis in the recommended plan is placed on control of point sources.

Some questions exist with respect to the degree of point source control necessary to affect compliance with the Class "C" water quality standards at various locations in the study area. Consequently, the recommended plans for municipal discharges include a step-by-step approach to improvement of waste treatment which will allow determination of the impact on water quality of a treatment improvement before a further improvement is made.

It is apparent that infiltration and inflow are excessive in many collection systems in the study area. It is recommended that measures be taken to reduce infiltration as soon as possible in order to extend the life of existing treatment facilities and reduce the volume of waste flow to be treated at new plants.

RECOMMENDED MUNICIPAL WASTEWATER FACILITIES

The recommended plan for the unsewered areas is to continue to use septic tank systems wherever soil and site conditions permit. If health hazards or water quality problems become apparent, it may be necessary to construct collection and treatment facilities. This should be done only when it is clearly apparent that well designed and properly constructed and maintained septic tank systems are ineffective.

Davis County

Both North and Central Davis will continue to treat their wastes separately.

The North Davis plant has a design capacity of 19.0 MGD, which is expected to be reached in 1990. Thus, no major additions are needed to meet the 1977 secondary treatment requirements, although additional sludge digesters and drying beds may be required soon. To meet the 1980 interim effluent standards, level III treatment will be necessary. During the year following the introduction of level III treatment, an intensive receiving water monitoring program must be conducted to determine whether the discharge results in the violation of Class "C" receiving water standards. If so, additional treatment processes or an outfall will be required before 1983.

The Central Davis plant has a design capacity of 6.0 MGD, with the exception of the sludge-handling facilities. This flow rate is not expected to be reached until about 1995. Treatment level III must be added by 1980, and treatment level IV or an outfall by 1983, if subsequently shown to be necessary.

The South Davis County Sewage Improvement District operates two plants: the 2.3 MGD South plant and the 5.3 MGD North plant. It tentatively appears that the South plant should be progressively phased out and the entire flow from the District be treated at the North plant. To comply with the 1977 secondary treatment standards, only minor modification of the plants will be

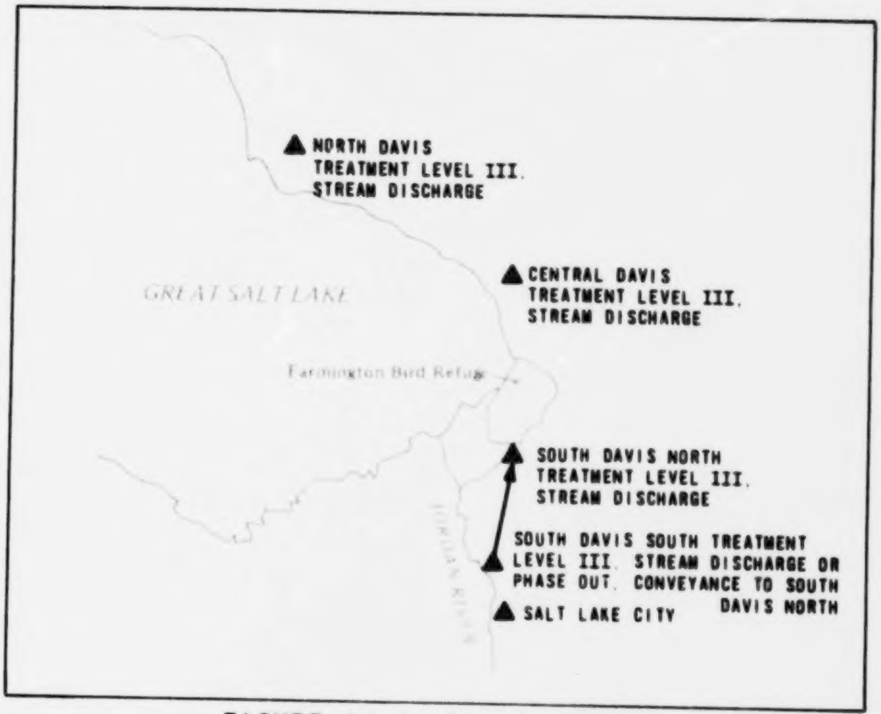

NORTH DAVIS
TREATMENT LEVEL III.
STREAM DISCHARGE
CENTRAL DAVIS
TREATMENT LEVEL III.
STREAM DISCHARGE
GREAT SALT LAKE
Farmington Bird Refuge
SOUTH DAVIS NORTH
TREATMENT LEVEL III.
STREAM DISCHARGE
JORDAN RIVER
SOUTH DAVIS SOUTH TREATMENT
LEVEL III. STREAM DISCHARGE OR
PHASE OUT. CONVEYANCE TO SOUTH
DAVIS NORTH
SALT LAKE CITY

FIGURE 14-1, DAVIS COUNTY
RECOMMENDED PLAN, 1980

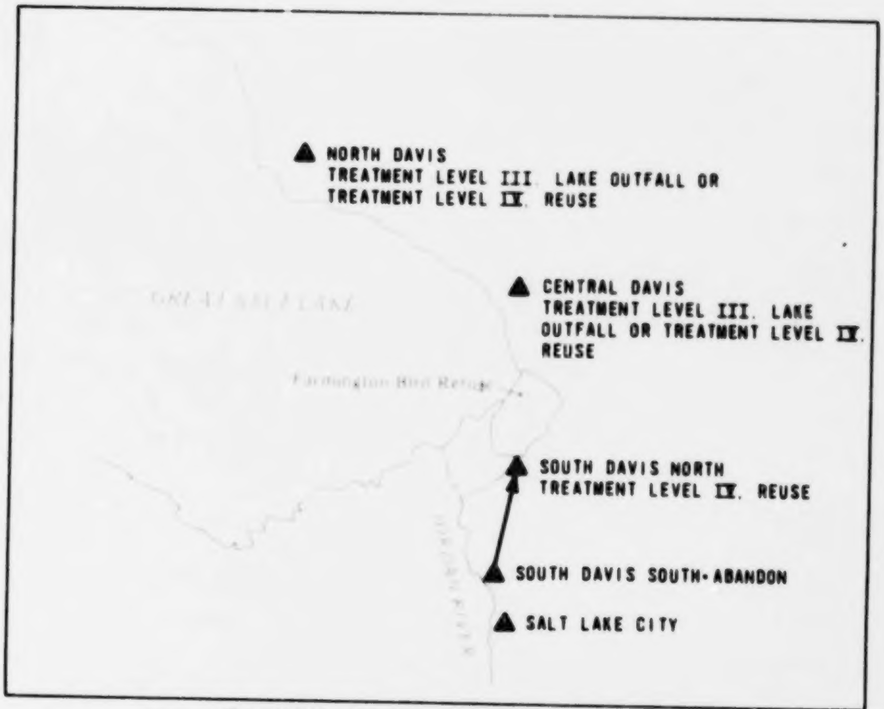

NORTH DAVIS
TREATMENT LEVEL III. LAKE OUTFALL OR
TREATMENT LEVEL IV. REUSE
CENTRAL DAVIS
TREATMENT LEVEL III. LAKE
OUTFALL OR TREATMENT LEVEL IV.
REUSE
GREAT SALT LAKE
Farmington Bird Refuge
SOUTH DAVIS NORTH
TREATMENT LEVEL IV. REUSE
JORDAN RIVER
SOUTH DAVIS SOUTH-ABANDON
SALT LAKE CITY

FIGURE 14-2, DAVIS COUNTY
POSSIBLE DEVELOPMENT OF RECOMMENDED PLAN, 1983-1995

necessary. To comply with the 1980 interim effluent standards, two options are available; level III treatment may be added at both the North and South plants, or phase out of the South plant begun by construction of conveyance facilities to the North plant and level III treatment facilities constructed there only. If level III treatment proves sufficient to meet Class "C" water quality standards, the economic argument for consolidation of treatment is not as strong as in the case of level IV treatment. It should be noted, however, that some benefit to water quality can be expected as a result of moving the South plant discharge to the Jordan River several miles downstream. A final decision on this option will be deferred until a more detailed cost effectiveness analysis of the options is made as part of facilities planning to be undertaken by the district.

The need for treatment in excess of level III will be determined from the results of a receiving water quality monitoring program.

Salt Lake County

Wastewater treatment in the Salt Lake City metropolitan area will be regionalized at two sites: the Salt Lake City plant and at, or in the vicinity, of the Salt Lake City Suburban Sanitary District No. 1 plant site.

To maximize the considerable economic and environmental benefits of regionalization, treatment must be centralized and many of the existing plants must be phased out. Some opinions have been expressed that perhaps advanced treatment alone should be regionalized and secondary effluent conveyed to the regional plant from expanded local secondary plants. Much of the savings in operation and maintenance costs resulting from regionalization are not realized by this system. It is apparent, however, that while total regional treatment must remain the ultimate goal, interim conveyance of secondary effluent to the regional treatment facilities may in some cases provide a practical means of moving toward that goal. It should be noted that capital expenditures at plants ultimately to be phased out must be minimized if the plan is to be cost-effective.

Many of the treatment plants in the area are nearing or exceeding their design capacity. In order to meet the 1977 secondary treatment requirements, it will be necessary to upgrade these plants or else construct the conveyance facilities to carry the excess flows to a plant with remaining capacity. The Salt Lake City Suburban Sanitary District No. 1 plant could

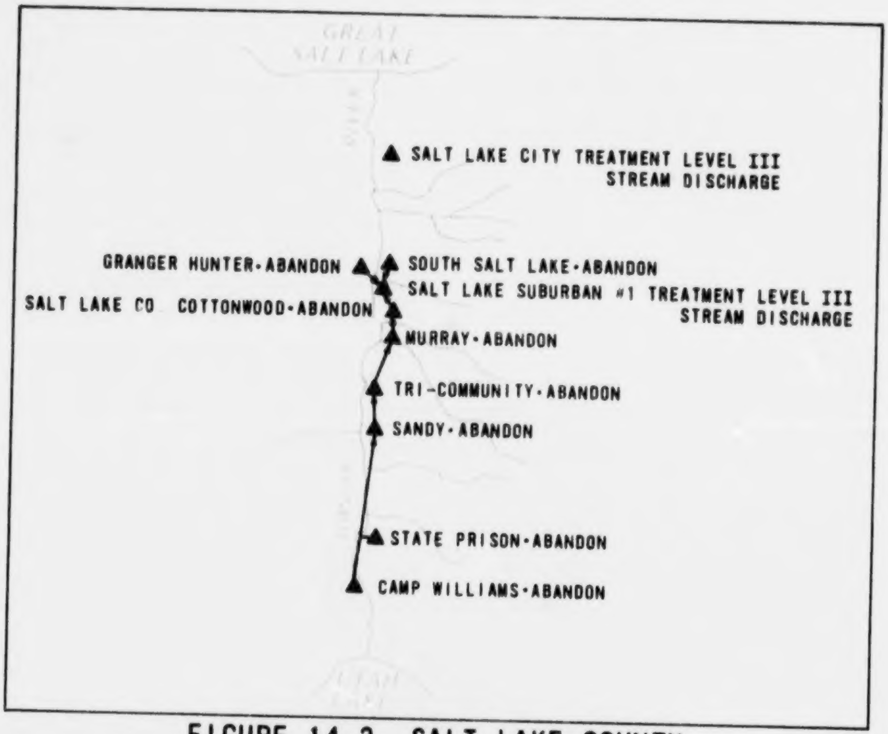

GREAT SALT LAKE
SALT LAKE CITY TREATMENT LEVEL III STREAM DISCHARGE
GRANGER HUNTER-ABANDON
SOUTH SALT LAKE-ABANDON
SALT LAKE SUBURBAN #1 TREATMENT LEVEL III STREAM DISCHARGE
SALT LAKE CO. COTTONWOOD-ABANDON
MURRAY-ABANDON
TRI-COMMUNITY-ABANDON
SANDY-ABANDON
STATE PRISON-ABANDON
CAMP WILLIAMS-ABANDON
UTAH LAKE

FIGURE 14-3, SALT LAKE COUNTY
RECOMMENDED PLAN, 1980

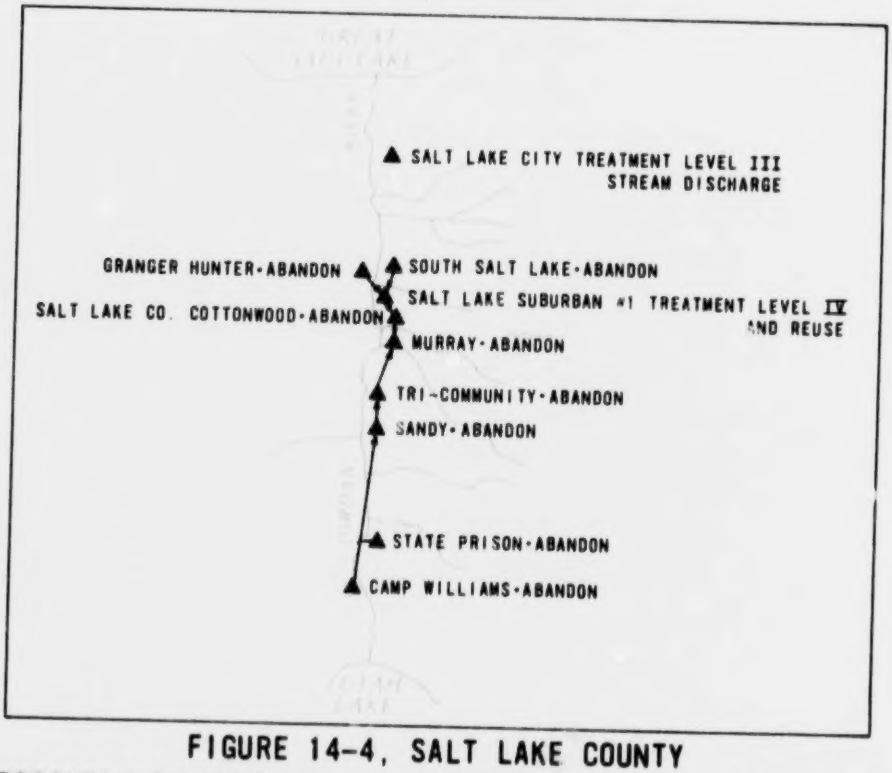

GREAT SALT LAKE
SALT LAKE CITY TREATMENT LEVEL III STREAM DISCHARGE
GRANGER HUNTER-ABANDON
SOUTH SALT LAKE-ABANDON
SALT LAKE SUBURBAN #1 TREATMENT LEVEL IV AND REUSE
SALT LAKE CO. COTTONWOOD-ABANDON
MURRAY-ABANDON
TRI-COMMUNITY-ABANDON
SANDY-ABANDON
STATE PRISON-ABANDON
CAMP WILLIAMS-ABANDON
UTAH LAKE

FIGURE 14-4, SALT LAKE COUNTY
POSSIBLE DEVELOPMENT OF RECOMMENDED PLAN, 1983-1995

accept another 3 or 4 mgd of flow with only minor modifications and perhaps as much as 5 or 6 mgd if a recently initiated sewer inspection and renovation program proceeds successfully. Therefore, it is imperative that the conveyance facilities from Tri-Community to Salt Lake City Suburban Sanitary District No. 1 be constructed as soon as possible and the excess flows from Sandy, and Tri-Community plant be conveyed to Salt Lake City Suburban Sanitary District No. 1 plant for secondary treatment as an interim solution, while the regional facility is being planned and constructed.

An unusual feature of the area is the overlap in sewage collection facilities. Some amelioration of the problem of overloaded treatment plants may be obtained by diverting portions of the wastewater flow from one entity's collection system to another. This might be considered as a short-term solution in some cases, while the permanent conveyance facilities are being designed and constructed. Excess flows in the Salt Lake County Cottonwood, and Murray systems might be particularly amenable to this solution. Conveyance facilities from South Salt Lake and Granger-Hunter may not be quite as urgent but would need to be completed prior to July 1, 1980.

It may also be necessary to implement interim upgrading at some of the plants to maintain an acceptable secondary effluent until the conveyance facilities and/or regional treatment facilities are completed. Capital expenditures should be minimized in that case and emphasis be placed on equipment modifications, chemical addition, temporary facilities, etc.

Immediate attention to identification and elimination of excessive infiltration/inflow waters in the collection systems would likely prove to be the most valuable component in the total interim plan to move from the present situation to the regionalization plan, while maintaining an acceptable secondary effluent from the existing facilities.

In order to meet the 1980 interim effluent standards, it will be necessary to construct an advanced treatment addition at Salt Lake City and another at Salt Lake City Suburban Sanitary District No. 1 capable of handling the combined flow to these regionalized plants. Any remaining sections of the conveyance system linking the existing collection systems with Salt Lake City Suburban No. 1 will need to be constructed. At this time, the Sandy, Tri-Community, Murray, Cottonwood, Granger-Hunter, and South Salt Lake plants can either be phased out or maintained as secondary facilities with excess flows and raw sewage conveyed to the regional plant. The latter course of action involves some unresolved technical difficulties and should be considered only if its cost-effectiveness can be demonstrated. It appears that early abandonment of these plants is the preferable course of action.

After a period of intensive water quality monitoring, the need for additional treatment or dispersion in order to meet the Class "C" standards will be determined. If necessary, additional treatment facilities will be constructed at the two regional plants by 1983.

Utah and Northern Juab Counties

Wastewater treatment in the northern and central portions of Utah County will be regionalized at two to five locations: American Fork, Orem, Provo, Salem, and Payson, with the option of further consolidation of treatment at Orem, Payson, and Provo. In Northern Utah County, the Lehi, Pleasant Grove, and American Fork treatment plants are operating at or close to capacity. To meet the 1977 secondary treatment requirements, it may be necessary to convey excess flows from Lehi and Pleasant Grove to an expanded American Fork plant, although rigorous programs for control of infiltration and inflow may defer the need for additional capacity until the regional facility is complete. Two options exist for staging regionalization at American Fork: construction of conveyance facilities from Pleasant Grove and Lehi to American Fork, expansion of the treatment facilities at American Fork to provide capacity for all three communities and early abandonment of the Lehi and Pleasant Grove plants; or construction of conveyance facilities from Pleasant Grove and Lehi to American Fork, conversion of Lehi and Pleasant Grove plants to expanded primary treatment and expansion of existing or construction of new secondary facilities at, or near, American Fork. From the point of view of water quality, either course of action attain the same result; hence, a decision can be made by the local communities on the basis of cost-effectiveness and expediency as determined by their facilities planning.

The Orem plant appears to have sufficient capacity to meet the 1977 standards without expansion.

In order to meet the 1980 interim effluent standards, it will be necessary to construct level III plants at, or near, American Fork and at Orem. Sub sequent results of a year of receiving water quality monitoring at American Fork and Orem will provide the basis for determining the need for additional treatment. If proved necessary, a lake outfall or treatment level IV will

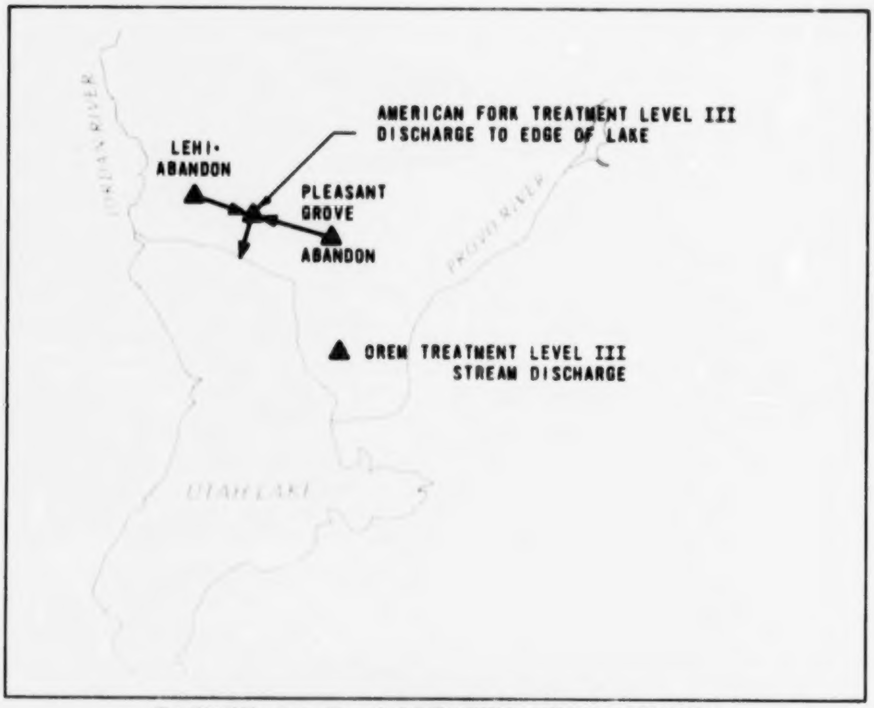

JORDAN RIVER
AMERICAN FORK TREATMENT LEVEL III
DISCHARGE TO EDGE OF LAKE
LEHI-
ABANDON
PLEASANT
GROVE
ABANDON
PROVO RIVER
OREM TREATMENT LEVEL III
STREAM DISCHARGE
UTAH LAKE

FIGURE 14-5, NORTHERN UTAH COUNTY
RECOMMENDED PLAN, 1980

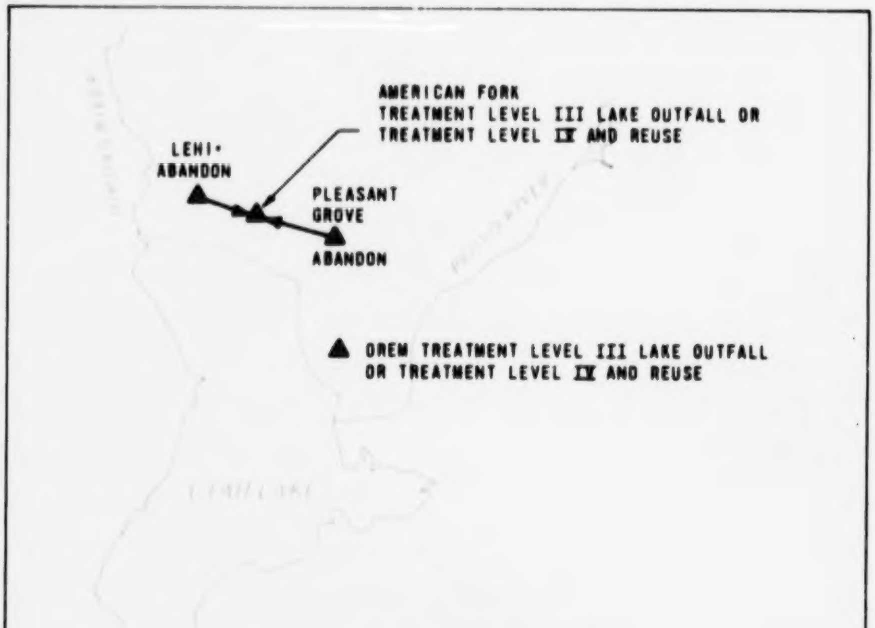

JORDAN RIVER
AMERICAN FORK
TREATMENT LEVEL III LAKE OUTFALL OR
TREATMENT LEVEL IV AND REUSE
LEHI-
ABANDON
PLEASANT
GROVE
ABANDON
PROVO RIVER
OREM TREATMENT LEVEL III LAKE OUTFALL
OR TREATMENT LEVEL IV AND REUSE
UTAH LAKE

FIGURE 14-6, NORTHERN UTAH COUNTY
POSSIBLE DEVELOPMENT OF RECOMMENDED PLAN, 1983-1995

be constructed at American Fork and Orem prior to 1983. The primary plants at Lehi and Pleasant Grove, if still in operation, will be phased out and replacement capacity constructed at the American Fork facility.

In Central Utah County, both the Provo and Spanish Fork treatment plants are taxing their capacity. To meet 1977 secondary standards, the Provo secondary facilities will be expanded. Conveyance facilities should be constructed to transport excess flows from Spanish Fork to Provo for treatment. The Springville, Salem, and Payson plants are expected to have sufficient capacity to meet the 1977 standards without expansion. All of these communities should initiate infiltration/inflow control programs in the near future.

To meet the 1980 interim effluent standards, level III treatment facilities will be constructed at Provo to handle the combined flows from Provo, Springville, and Spanish Fork. The Springville plant will be connected to the interceptor linking Spanish Fork with Provo. Two options exist for Salem and Payson because the economic advantages obtained by their participation in the regional system are marginal: connect to the regional system or retain their existing plants with secondary effluent from Salem conveyed to a level III treatment facility at Payson. A preferred course of action should be identified as part of a facilities plan. It appears that if the existing secondary capacity at Payson proves adequate for the next 20 to 25 years, regionalization with Provo would not be appreciably less costly. However, if any substantial enlargement of the secondary portion of the facility is necessary, regionalization would result in a significant cost savings.

The question of "adequate" capacity raises an important point that is not reflected in the cost analyses given in Chapter 13. In areas of high potential growth, as is the case in Central Utah County, smaller treatment facilities must be sized with a substantial "reserve" capacity to cover the possibility of high growth rates in the service area. With regionalization, the total design capacity can be substantially reduced for two reasons: (1) the peak flows arrive at the plant at different times - hence, the combined peak flow is considerably less than the sum of the subarea peaks; and (2) the growth in the larger area is generally more predictable - hence, less capacity reserve is necessary.

After a period of intensive water quality monitoring, the need for additional treatment of dispersion at the remaining plants in order to meet the Class "C" standards will be determined.

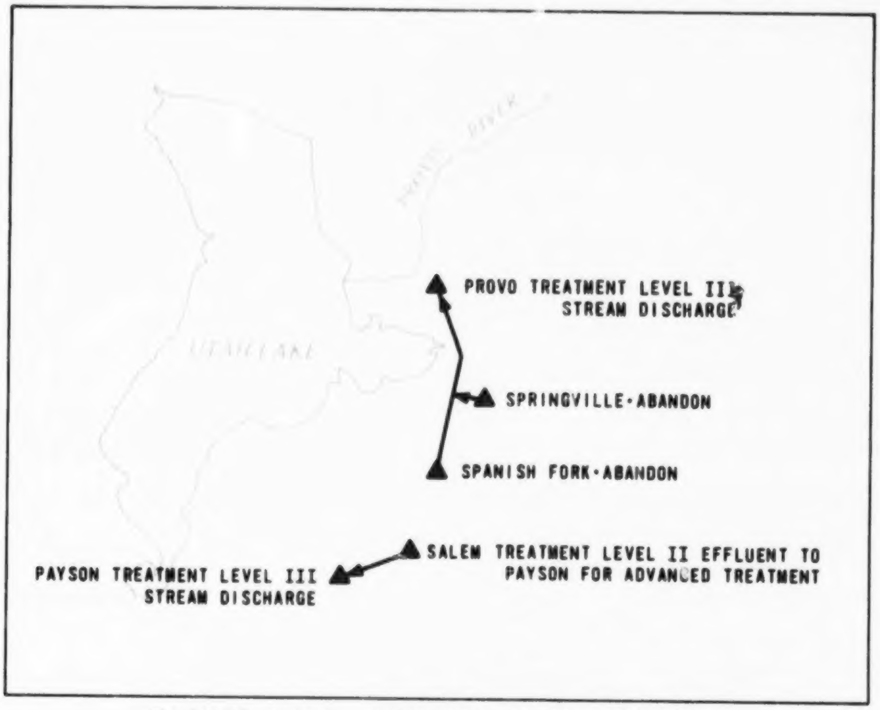

PROVO RIVER
UTAH LAKE
PROVO TREATMENT LEVEL III STREAM DISCHARGE
SPRINGVILLE-ABANDON
SPANISH FORK-ABANDON
SALEM TREATMENT LEVEL II EFFLUENT TO PAYSON FOR ADVANCED TREATMENT
PAYSON TREATMENT LEVEL III STREAM DISCHARGE

FIGURE 14-7, CENTRAL UTAH COUNTY
RECOMMENDED PLAN, 1980

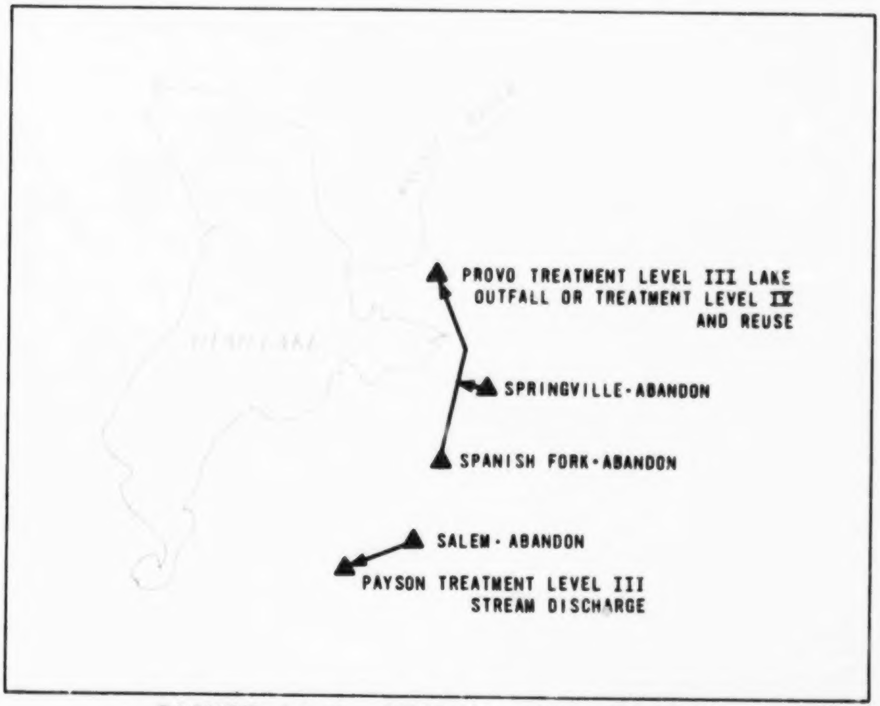

PROVO RIVER
UTAH LAKE
PROVO TREATMENT LEVEL III LAKE OUTFALL OR TREATMENT LEVEL IV AND REUSE
SPRINGVILLE-ABANDON
SPANISH FORK-ABANDON
SALEM-ABANDON
PAYSON TREATMENT LEVEL III STREAM DISCHARGE

FIGURE 14-8, CENTRAL UTAH COUNTY
POSSIBLE DEVELOPMENT OF RECOMMENDED PLAN, 1983-1995

At the time the regional conveyance system is completed, it will be possible to phase out the Spanish Fork and Springville plants; however, opinions have been expressed that advanced treatment alone be regionalized and secondary effluent conveyed to the regional plant from expanded local secondary plants. Although the impact on water quality is the same, in the long run, much of the savings in operation and maintenance costs resulting from regionalization is not realized by this system; these savings are the major factor that makes regionalization attractive. It is apparent, however, that while total regional treatment must remain the ultimate goal, interim conveyance of secondary effluent to regional advanced treatment facilities provides a practical means of moving toward that goal. It should be emphasized that capital expenditures at plants ultimately to be phased out must be minimized if the plan is to be cost-effective.

Nephi should continue to use its wastewater lagoons as a total containment system unless problems develop, in which case it may be necessary to construct more sophisticated treatment facilities.

Wasatch County

In the long run, it appears advantageous to regionalize wastewater treatment in Wasatch County at a single location--a new regional treatment plant near Charleston.

The existing Heber City wastewater treatment plant is grossly overloaded due to the massive infiltration/inflow of ground and surface waters into the collection system. Sanitary sewage flow from the community should only be about 0.5 mgd; however, it is currently averaging nearly 3 mgd and exceeds 6 mgd during summer peak-flow conditions. The present plant capacity is 1.5 mgd. Infiltration/inflow reduction should be pursued diligently with the goal of reducing the flow to within the capacity of the existing plant by July 1, 1977; even then it may be necessary to upgrade the treatment to meet the required secondary effluent standards.

Facilities planning should address the cost effectiveness of regionalization. The economics will rest heavily on the design capacity for Heber City as based on the success of the flow reduction program and also on the extent to which various proposed and partially developed recreational and subdivision areas in Heber Valley have proceeded at that time.

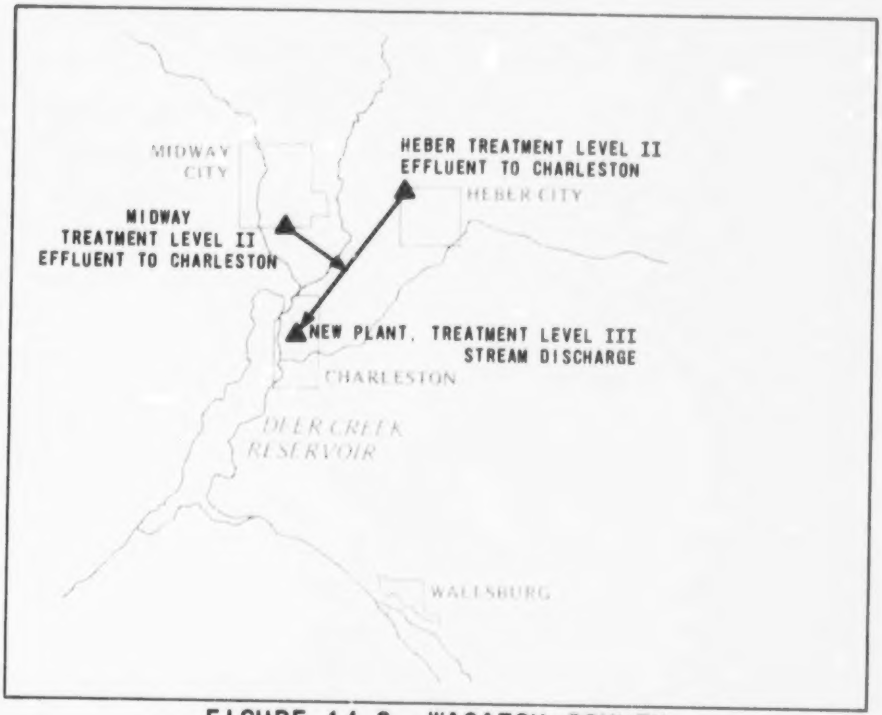

MIDWAY CITY
HEBER TREATMENT LEVEL II EFFLUENT TO CHARLESTON
HEBER CITY
MIDWAY TREATMENT LEVEL II EFFLUENT TO CHARLESTON
NEW PLANT, TREATMENT LEVEL III STREAM DISCHARGE
CHARLESTON
DEER CREEK RESERVOIR
WALLSBURG

FIGURE 14-9, WASATCH COUNTY
RECOMMENDED PLAN, 1980

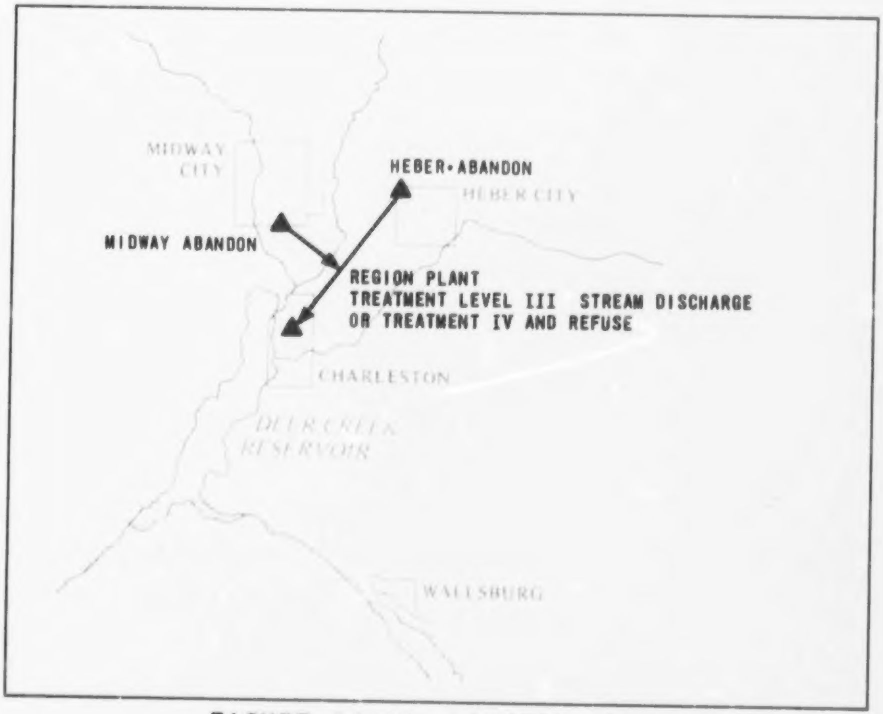

MIDWAY CITY
HEBER-ABANDON
HEBER CITY
MIDWAY ABANDON
REGION PLANT
TREATMENT LEVEL III STREAM DISCHARGE
OR TREATMENT IV AND REFUSE
CHARLESTON
DEER CREEK RESERVOIR
WALLSBURG

FIGURE 14-10, WASATCH COUNTY
POSSIBLE DEVELOPMENT OF RECOMMENDED PLAN, 1983-1995

Cost analyses conducted in this study indicate that regionalization at a single site near Charleston is the preferable plan but the uncertainties in this case mandate that the decision be dererred and be addressed under the pertinent guidelines in the "201" facilities planning for the area.

To meet the 1980 interim effluent standards, if regionalization is undertaken, conveyance facilities will be constructed from Midway and Heber to the new plant site near Charleston. If, as a result of infiltration control measures, it becomes apparent that the Midway and Heber plants can continue to effectively treat the full flow of wastes from these two communities, then the initial function of the regional plant may be limited to advanced treatment of secondary effluent from the older plants. If this is the case, the existing Heber and Midway plants will be phased out and replacement capacity built at the new regional facility as soon as it becomes cost-effective to do so.

After a period of intensive water quality monitoring, the need for additional treatment in order to meet the Class "C" standards will be determined. If necessary, additional treatment facilities will be constructed at the regional plant by 1983.

Before resources are committed to the recommended plan, it will be necessary to make a final decision with respect to the possibility of conveying wastewater out of the county to Provo for treatment. This alternative offers considerable environmental benefits, although it is both expensive and difficult to implement.

RECOMMENDED INDUSTRIAL WASTEWATER MANAGEMENT STRATEGY

Industrial wastewater dischargers must comply with both the State of Utah's interim effluent standards and Federal regulations. Specific effluent limitations are being promulgated for existing industrial waste discharges, together with standards of performance and pretreatment standards for new sources, pursuant to sections 304(b), and 306(b), and 307(b) of the Federal Water Pollution Control Act. Waste source categories of particular interest in the basin which will be covered by those sections of the Federal law include: petroleum refining, steam electric power plants, inorganic chemical manufacturing, nonferrous metal manufacturing, canned and preserved fruit and vegetable processing, beverages, iron and steel manufacturing and fertilizer manufacturing.

Because the details of these limitations have not been finalized, it is possible to predict whether or not their enforcement will result in compliance with water quality standards. Thus no recommendations are made with respect to industrial wastewater management beyond those measures already required by existing law.

RECOMMENDED NON-POINT SOURCE CONTROL MEASURES

Wastewaters originating from non-point sources include urban runoff, agricultural irrigation return flow and drainage from animal compounds, construction sites and mines. Control of non-point wastewaters can be accomplished in several ways: Prohibition of polluting activities, changes in practices to minimize waste emission, and treatment of wastes. Some of these measures were discussed in detail in Chapter 11.

At the present time the overall significance of non-point waste sources to basinwide water quality is uncertain, although non-point source wastes clearly influence water quality in certain streams to a considerable degree. In addition, it is recognized that both prohibition of polluting activities and treatment of non-point wastes are extreme measures in that they would be technically and politically difficult and costly. Thus it is recommended that the short-term emphasis in non-point source control be placed on changes in practices that minimize waste production. As a more complete understanding of the role of non-point source pollutants in basinwide water quality develops, further measures may prove necessary.

Urban Runoff Control

The following measures would reduce urban runoff waste emissions. In many cases they have secondary benefits with respect to aesthetics and public amenities.

1. Diligent enforcement of anti-litter laws.
2. Increased street-cleaning efforts, thus eliminating the flushing of debris into storm sewers.
3. Improved maintenance of street surfaces.

4. Increased cleaning frequency of catch-basins.
5. Keep street maintenance personnel informed on new methods of control with respect to urban runoff and water pollution.
6. Prevention of excessive street salting.
7. Prohibition of the use of storm drainage channels as a repository for snow cleared from city streets.

Control of Agricultural Wastes

Certain agricultural waste sources are not considered to be non-point sources and consequently will be regulated under the permit system, as described in the 1972 amendments to the Federal Water Pollution Control Act. Permits are required for:

1. feedlots with 1,000 or more slaughter steers and heifers;
2. dairies with 700 head or more, including milkers, pregnant heifers and dry mature cows but not calves;
3. swine facilities with 2,500 or more 55-pound swine;
4. sheep feedlots with 10,000 head or more;
5. turkey lots with 55,000 birds, unless the facilities are covered and dry;
6. laying hens and broilers, with continuous-flow watering and 10,000 or more birds;
7. laying hens and broilers with liquid manure handling systems and 30,000 or more birds; and
8. irrigation return flow from 3,000 or more acres of land when conveyed to navigable waters from one or more point sources.

In addition, smaller agricultural operations that are identified as a significant source of water pollution will be included in the permit program.

The Utah State Division of Environmental Health is currently identifying agricultural waste sources that will require permits. Mitigation measures that would reduce waste loads to surface waters from non-point agricultural sources are recommended below.

Control of animal confinement operations:

1. Confinement facilities should be located well away from surface water.
2. Surface runoff including drainage from roofed areas should be confined to croplands or lagoons.
3. Lands used for disposal of manure and liquid wastes should be managed to minimize erosion and runoff.

Surface water pollution due to irrigation return flow may be minimized by the implementation of the following measures:

1. Prevention of irrigation diversions in excess of crop requirements. However, the quantities should be adequate to allow leaching of excess salts from the root zone.
2. Adoption of more efficient irrigation methods.
3. Improved management in applying commercial fertilizers to reduce the quantities in the return flows.
4. Management of the use and re-use of water to minimize solute buildup in the waters.

RECOMMENDED STRATEGY FOR MANAGEMENT OF RESIDUAL SOLIDS FROM WASTEWATER TREATMENT

The volume of residual solids produced as a result of wastewater treatment increases with the degree of treatment. Application of level III treatment will increase solids production by 5 to 15 percent. Level IV treatment will not result in a significant increase in residual solids although several difficult to treat aqueous streams are introduced. Solids volume will obviously increase, however, as wastewater flows increase.

No detailed analysis of solids disposal in the study area was conducted as present practices appear to be generally satisfactory. Air-drying of sludges on open beds and subsequent land disposal of the residue is effective and relatively nuisance-free and hence this practice should be contined.

The present practice of direct landfilling of sludges withdrawn from sewage vaults in the canyons is unacceptable, except under carefully controlled conditions. These sludges should be treated in a specially designed system or added at a controlled rate to the influent of an existing wastewater treatment plant.

RECOMMENDED INSTITUTIONAL ARRANGEMENTS

Many and otherwise technically excellent sbheme has failed merely on the basis of institutional infeasibility or a lack of attention to the requirements of the social and political structures within which the scheme was supposed to operate. Technical solutions to existing environmental problems are almost invariably applied through societal structures which are well established and tend to perpetuate themselves. Thus, it is incumbent upon planners to present institutional solutions--as well as technical ones--especially where cooperation and coordination among a number of agencies are a prerequisite to plan implementation. Such institutional solutions, of necessity, must recognize the rates at which obso-

No hard-and-fast recommendations with respect to institutional arrangements are made in this section. Development of the administrative structure necessary to implement the plan is ultimately the responsibility of the local communities. Some institutional possibilities are discussed in order of their desirability, together with financial and legal constraints.

Financial Aspects

A review of the financial status of the various agencies responsible for sewage service, together with the estimated costs of the recommended facilities, only 25 percent of which would be borne by the local agencies, leads to the preliminary conclusion that the recommended plans are financially feasible.

Legal Constraints

There is presently no legal authority for the creation of a "super agency" responsible for water quality management overlapping the existing sewerage districts. New legislation would be necessary to create such an agency. Although there appear to be no formidable obstacles to drafting enabling legislation for consideration by the 1975 Utah Legislature, it is apparent that steps toward consolidation of sewage treatment must be taken before any such effort can come to fruition. Two other consolidation mechanisms may be used: An association of agencies under the Interlocal Co-operation Act, and contractual arrangements with a single existing agency for treatment of sewage.

Interlocal Co-operation Act, 1965

The Interlocal Co-operation Act (UCA 11-13) of 1965 makes it possible for public agencies to contract with one another where their mutual advantage is served best. Cities, towns, counties, special districts, and the various agencies of the State government are empowered to make agreements whereby the legally authorized powers of one agency may be exerted within the jurisdiction of the other(s). The law requires that a joint board be created whenever two agencies agree to work together to solve a common problem. This board administers the responsibilities of the joint effort, while the individual entities remain responsible for their own legal undertakings and obligations. The Attorney General must review all interlocal agreements. Officers of State governments who may have Constitutional or statutory responsibility for the area affected by the agreement must also approve the joint effort. Joint ownership, contribution of funds, personnel, equipment, etc. are allowed in such agreements when ratified by all the individual governing bodies involved. The new authority may issue bonds in order to acquire the necessary facilities. Agreements must not extend beyond the boundaries of the areas normally served by member agencies.

An Association of agencies might be formed which could enter into a mutually acceptable agreement, the purpose of which would be to set forth the manner in which the parties are associated to jointly provide sewerage service, the manner in which funds would be provided for construction and acquisition of facilities and equipment and the manner in which the parties thereto would regularly contribute toward the costs of maintenance, operation and the liquidation of obligations (other than bonds) incurred by the Association.

The respective parties would agree to loan the amounts of money (for example, in ratio of assessed value to project cost) to the Association to provide the necessary facilities and might additionally loan or donate such other funds as their respective governing bodies may authorize. The loans would be repaid by the Association to the respective parties in such manner and in such amounts and with such frequence of payment together with interest at such rates as may be established by the Association Board and the governing body of the appropriate municipality.

In the event that the agency has issued bonds or otherwise borrowed funds so loaned to the Association, the method of repayment and rate of interest should be the same as that for which the municipality is obligated. Obviously,the agency could not exceed its individual statutory or constitutional debt limit for sewer purposes. Revenue bonds might be issued subject to the usual scrutiny and restrictions but would be substantially less marketable.

It might also be possible for the members of the Association which do not have sufficient debt capacity to modify their agreement to contract with a stronger entity such as Salt Lake City or Salt Lake County Suburban Sanitary District #1 to build the treatment plant and to pay correspondingly higher service fees in lieu of higher debt service.

Contractual Agreement with a Single Agency

It is possible for a sewage collection agency to contract with another agency for sewage treatment. One disadvantage with this type of agreement is that the sewage collection agencies frequently voice the fear that, because they are not represented on the Board of the treatment agency, they may be subject to a disproportionate share of the costs incurred for treatment.

Recommended Institutional Arrangements

Davis County--

Consolidation of wastewater facilities beyond that already implicit in the existing sewerage service agency jurisdictions is not recommended. The present institutional arrangements function well, but serious consideration should be given to joint management and operations agreements between the entities.

Salt Lake County

In a densely populated area like Salt Lake County, a "super agency" responsible for all aspects of water quality management offers many advantages and is the most desirable institutional arrangement.

In view of the legislative changes necessary to accomplish the above, the presently most feasible arrangements are as follows: no change in arrangements at Salt Lake City, Magna, Copperton and Lark; consolidation of treatment in the South Salt Lake Valley under the provisions of the Interlocal Co-operation Act or, as a second and less desirable option, contractual agreements between Salt Lake City Suburban Sanitary District No. 1 and the other sewage agencies to provide treatment at the District's plant.

Utah County

Consolidation of wastewater treatment in the American Fork, Lehi, and Pleasant Grove area can best be accomplished by formation of an Association under the Interlocal Co-operation Act. This is also true for the Provo, Springville, and Spanish Fork area. Salem and Payson may be a party to the Association in Central Utah County.

Second options for each area are contractual agreements for wastewater treatment with American Fork and Provo, respectively.

In view of the dispersed nature of the population, a county-wide "super agency" does not appear to offer significant advantages and is generally opposed locally as incompatible with the County's land-use planning activities.

Wasatch County

Consolidation of wastewater treatment for Heber, Midway, Charleston and future developments at a location near Charleston can best be accomplished by the formation of an Association under the Interlocal Co-operation Act. Because of the high development potential of Heber Valley and the desirability of providing sewage treatment at a single location, a county-wide or at least area-wide sewerage agency would offer some advantages in Wasatch County.

ENVIRONMENTAL IMPACT OF THE RECOMMENDED PLAN

As is evident from the foregoing chapters environmental considerations were integrated with the decision and selection processes throughout the study. Thus the recommended plan was selected in part on the basis of environmental impact assessment. It is necessary however, that the probable environmental impact of the recommended plan be summarized in the format of an environmental impact report as defined in the National Environmental Policy Act (1970).

Project Description

This section is included in an earlier part of this chapter.

Project Setting

This section is included in Chapters 3 and 4.

Probable Impact of the Recommended Plan

Beneficial impacts of the recommended plan include:

1. Improvement in stream water clarity, dissolved oxygen content and faunal species diversity in surface streams and lakes affected by wastewater discharge.
2. Abandonment of approximately two-thirds of the existing wastewater treatment facilities leading to community benefits of reduced nuisance, i.e. odor, noise and inappropriate land use.
3. Improvement in protection of public health.

Negative impacts of the recommended plan include:

1. Community dislocation as a result of construction activities necessary to implement the recommended plan.
2. Some destruction of habitats during construction period.

Unavoidable Adverse Impacts

1. Temporary dislocation as a result of construction activities necessary to complete the facilities required by the plan.

2. Some destruction of habitats as a result of construction activity.

Mitigation Measures

1. Some of the adverse impacts of the construction phase may be mitigated by specifying certain improved construction practices and by attention to environmental concerns during the design phase.

Irretrievable commitments of Resources

1. The use of materials, labor, funds and energy to construct the facilities required to implement the plan represents an irretreivable commitment of resources.
2. Use of land for treatment facilities represents a permanent commitment of resources precluding other land use options.

Growth Inducement Potential

The size of facilities recommended in the plan are based on estimates of future wastewater quantities which are themselves based on population projections contained in the county master plans. The facilities are sized to service the planned growth in population rather than as an inducement to further growth.

Communities that do not provide adequate sewage collection, treatment and disposal service may be the subject of growth control measures such as sewer connection bans. Implementation of the recommended plan would reduce the likelihood of this eventuality. Still, people do not choose their homes on the basis of the merits of the communities sewerage service and thus the plan is expected to have little direct impact on residential development.

Industry, on the other hand, considers the cost and availability of wastewater treatment and disposal service and environmental regulations in its long range plant location decision making. However, it is not susually of paramount importance unless the industry produces difficult to treat or large volume wastes. The recommended plan for industry requires compliance with Utah's interim effluent standards which can be regarded as stringent when viewed from a national standpoint. Thus the plan is not expected to have a significant positive impact on industrial development.

Objections, If Any, and Their Resolution

This section is included in the discussion of the evaluation of alternatives in Chapter 13.

ESTABLISHMENT OF PRIORITIES

Many factors are involved in the development of priorities for the implementation of plan components. Some of the priorities are dictated by the State and Federal statutes while others are based on the relative seriousness of water pollution in different parts of the study area and the condition, capacity and effectiveness of existing treatment facilities. The Utah State Division of Health municipal inventory for 1975 is contained in Appendix 14-A. Basic environmentally related principles for establishment of priorities follow:

Highest Priority -	Measures designed to protect presently unpolluted mountain streams and water supply catchments.
Secondary Priority -	Measures designed to mitigate pollution of the waters of the Provo-Jordan River Parkway (i.e. the Jordan River and the lower reaches of the Provo River).
Tertiary Priority -	Measures designed to prevent or mitigate pollution of all other surface waters in the basins.

ENFORCEMENT

The principal mechanism by which the recommended plan will be enforced is the National Pollutant Discharge Elimination System (NPDES) or permit program presently administered by the Environmental Protection Agency. A policy for the issuance of discharge permits that supports the recommended plan is described below.

Municipal Point Sources

Permit conditions will become stringent in accordance with the following timetable.

Present to 1977	Permit conditions to reflect effluent quality attainable with existing facilities and best operating practices.
1977 to 1980	Permit conditions to reflect E.P.A. and State of Utah secondary treatment definitions, whichever are more stringent.
1980 to 1983	Permit conditions to reflect State of Utah interim effluent standards.
1983 to 1995	Permit conditions to reflect State of Utah interim effluent standards and E.P.A. best practicable treatment for municipal wastes, whichever are the more stringent, unless noncompliance with Class "C" water quality standards requires more stringent discharge regulations.

Adoption of the recommended plan will result in a reduction in the number of municipal wastewater discharges in the study are requiring permites from the present 29 to 13 to 17.

Industrial Point Sources

Permit conditions will become more stringent in accordance with the following timetable.

Present to 1977	Permit conditions to reflect effluent quality attainable by application of the industrial equivalent of secondary treatment.
1977 to 1980	Permit conditions to reflect E.P.A. best practible control technology definitions and Utah's secondary treatment definitions, whichever are the more stringent.

1980 to 1983	Permit conditions to reflect EPA best practicable control technology definitions and Utah's interim effluent standards, whichever are the more stringent.
1983 to 1995	Permit conditions to reflect EPA best available control technology definitions and Utah's interim effluent standards, whichever are the more stringent, unless noncompliance with Class "C" water quality standards requires more stringent discharge regulations.

It should be noted that many industries discharge wastes to canals and ditches that flow rapidly to the Great Salt Lake. Permit conditions addressing salt content of wastewaters should take account of the unusual nature of the receiving waters.

SURVEILLANCE AND MONITORING

A water quality management program cannot be implemented without a system to provide information on the operation and effectiveness of the program. Data must be acquired, verified and interpreted to ascertain changes and trends in water quality and to provide a basis for making necessary changes in the planning strategies and waste discharge permit conditions in order to meet the water quality standards.

For many years the State of Utah has maintained a monitoring network for measurement of physical and chemical water quality. The network, which began as a relatively modest system, has grown to approximately 308 stations statewide. There are about 156 stations in the study area. As shown in Figure 14-11, some modification of sampling frequencies and the number and types of parameters to be analyzed for are necessary to determine whether the waters of the State are in compliance with State and Federal regulations.

The Federal Water Pollution Control Act Amendments of 1972 require that the states have or establish fairly comprehensive monitoring programs, and the availability of construction grant funds is contingent on the implementation of such programs. Some of the monitoring requirements are defined explicitly (as in Section 106 of the Amendments), while others are implied in connection with other requirements.

General Monitoring Program Objectives

The general objectives of a water quality surveillance and monitoring program are:

1. to assess the achievability of water quality standards and goals and the overall objectives of the water quality management program;
2. to measure specific effects of water quality and changes in water quality on the desired beneficial uses of the waters;
3. to measure and document background water quality conditions and long-term trends in water quality changes;
4. to locate and identify sources of water pollution that pose an acute, cumulative or chronic threat to the environment;
5. to provide information needed to relate receiving water quality to mass emissions of pollutants by waste dischargers;
6. to provide data for determining waste discharger compliance with permit conditions;
7. to measure waste loads discharged to a receiving water body and identify the limits of their effect as a necessary step in the development of waste load allocations necessary to achieve water quality control;
8. to provide the documentation necessary to support the enforcement of permit conditions required of waste dischargers;
9. to provide data needed to carry on the continuing planning process;
10. to provide a clearinghouse for the collection and dissemination of water quality data gathered by other agencies and organizations;
11. to prepare reports on water quality conditions as required by Federal regulations.

Requirements of the Federal Water Pollution Control Act Amendments (Pl 92-500)

Section 106 of the Federal Water Pollution Control Act Amendments of 1972 (PL 92-500) states, in part, that no grants may be made to a state which has not provided or is not carrying out as part of its program "the establishment and operation of appropriate devices, methods, systems and procedures necessary to monitor, and to compile and analyze data, (including classification according to eutrophic conditions), on the quality of navigable waters and to the extent practicable, ground waters including biological monitoring; and provisions for annually updating such data and including it in the report required under Section 305 of this Act."

In addition to this section, other sections require or imply the requirement for monitoring. For example:

."...identify the location of in-place pollutants with emphasis on on toxic pollutants in harbors and navigable waterways..." (Section 115)

."...identify those waters ... for which effluent limitations are not stringent enough to implement any water quality standard applicable to such waters ..." (Section 303 [d][1][A]), and "... shall establish for the water identified in paragraph (1)(A) ... the total maximum daily load of ... pollutants ..." (Section 303 [d][1][C])

."...identify those waters ... for which controls on thermal discharges ... are not stringent enough to issue protection of ... shellfish, fish and wildlife" (Section 303 [d][1][B], and "... estimate for the waters identified in paragraph (1)(B) ... the maximum daily thermal load required to assure protection and population of ... shellfish, fish and wildlife ..." (Section 303 [d][1][D]

."Each state shall prepare and submit to the Administrator by January 1, 1975, and shall bring up to date each year thereafter a report which shall include:

... description of water quality of navigable waters

... an analysis of extent to which all navigable waters provide for the protection and population of ... shellfish, fish and wildlife and allow recreational activities ...

... description of the nature and extent of non-point sources of pollution ... recommendations as to control [of each category of sources] (Section 305[b][1]

."Each state shall prepare or establish and submit to the Administrator for his approval:

(1) an identification and classification according to eutrophic condition of all publicly owned fresh water lakes in such state; ..." (Section 314[a]). "The Administrator shall require the owner or operator of any point source to provide such ... information [for] determining whether any person is in violation of any ... effluent limitation, or other limitation, prohibition or effluent standard, pretreatment standard or standard of performance ..." (Section 308[a])

."Each state may develop and submit ... procedures under state law for inspection, monitoring and entry with respect to point sources ... If the Administrator finds that the procedures ... are applicable to at least the same extent as those required by this section, such state is authorized to apply and enforce its procedures for inspection, monitoring and entry ..." (Section 308[c])

Monitoring Needs

Review of the data requirements of the Utah State Division of Health and the requirements of the Federal law leads to the recommendation that an adequate surveillance and monitoring program should be made up of the following elements.

1. Primary Monitoring Network
2. Discharge Self-Monitoring Program
3. Compliance Monitoring
4. Special Surveys
5. Non-Point Source Investigations
6. Annual Water Quality Inventory
7. Laboratory Support and Quality Assurance
8. Data Storage, Retrieval and Reports

Primary Monitoring Network--

This element provides the basis for routine water quality monitoring.

It is divided into three types of networks.

- Fresh Surface Water Network
- Saline Surface Water Network
- Groundwater Network

These monitoring networks would provide the bulk of the water quality data required for enforcement and planning purposes.

A suggested set of parameters to be measured routinely and the frequency of measurement is presented in Table 14-1.

Discharger Self-Monitoring

Each municipal and industrial wastewater discharger is required to submit monthly reports describing and summarizing its wastewater discharge. These data should provide the primary data base for characterization of wastewater discharges. Table 14-2 presents the parameters and sampling frequency that should be required for municipal wastewater discharges where most of the wastewaters are of domestic origin.

It is more difficult to describe a monitoring program for industrial wastewater discharges because of the diversity of types of industry and the possible wastewater constituents. Table 14-2 lists parameters and a general sampling frequency for industrial wastewater effluents. In addition to the constituents listed in the table, other potential problem constituents should be monitored depending upon the industry and the nature of its wastewaters.

Compliance Monitoring

The purpose of compliance monitoring is to provide a check on the data provided by the Discharger Self-Monitoring program and to provide data for enforcement actions. All data collected under the compliance monitoring program will be stored with the data collected under the Primary Monitoring Network and the Discharger Self-Monitoring programs.

Compliance monitoring would be performed solely by State personnel. Because of the nature of the program, most compliance monitoring would be performed without advance notice to wastewater dischargers, and its scheduling should be random.

Emphasis (i.e., sampling intensity) in the compliance monitoring program would be placed on major dischargers. The emphasis in this program should be both on checking from an enforcement point-of-view and on working with the discharger to improve the quality of the wastewater discharge.

Special Surveys

Special surveys will be required in addition to routine monitoring and surveillance data. Such surveys will be made for specific, special water quality problems or because of enforcement action needs. Intensive surveys in water quality limited stream segments are required at least every five years by Federal law.

Data from special surveys will supplement the data obtained from the other monitoring programs and will be useful in long-range planning and in evaluation of the effectiveness of water quality control programs.

Non-Point Source Investigations

This study has found a dearth of information on non-point pollution sources in the study area--a situation that is common throughout the country. To a certain extent, the Primary Monitoring Network and the Special Surveys programs will be designed to fill this information need. However, additional effort will be required to characterize these problems.

The objectives of this program will be to provide data on the amounts and characteristics of pollutants from non-point sources, to provide other data useful in the management of such pollutants and to monitor the effectiveness of programs designed to control pollutants from non-point sources.

Annual Water Quality Inventory

Section 305(b) of PL 92-500 requires that by 1 January 1975 the State shall prepare and submit, and shall annually bring up to date, a report titled the Annual Inventory Report. This report shall include (a) a description of the water quality of major navigable waters in the State during the preceding year; (b) an analysis of the extent to which significant navigable waters provide for the protection and propagation of a balanced population of shellfish, fish and wildlife and allow recreational activities in and on the water; (c) an analysis of the extent to which elimination of the

Table 14-1

BASIC WATER QUALITY MONITORING PROGRAM

	Network and Sampling Frequency[a]		
Parameter	Freshwater	Saline Water	Groundwater
Physical			
Temperature	1/M[a]	1/M	1/M
Turbidity	1/M	1/M	
Color	1/M	1/M	1/M
Odor	1/M	1/M	1/M
Conductivity	1/M	1/M	1/M
Inorganic Chemical			
Dissolved Oxygen	1/M	1/M	1/M
pH	1/M	1/M	1/M
Total dissolved solids	1/M	1/M	1/M
Alkalinity	1/M	-	1/M
Sulphate	1/M	-	1/M
Chloride	1/M	-	1/M
Fluoride	4/Y	-	4/Y
Iron	1/M	1/Y	1/M
Manganese	1/M	1/Y	1/M
Arsenic	2/Y	1/Y	2/Y
Cadmium	2/Y	1/Y	2/Y
Hexavalent Chromium	2/Y	1/Y	2/Y
Copper	2/Y	1/Y	2/Y
Mercury	2/Y	1/Y	2/Y
Lead	2/Y	1/Y	2/Y
Silver	2/Y	1/Y	2/Y
Selenium	2/Y	1/Y	2/Y
Zinc	2/Y	1/Y	2/Y
Ammonia	1/M	1/Y	-
Organic Nitrogen	1/M	1/Y	-
Nitrate	1/M	1/Y	4/Y
Orthophosphate	1/M	1/Y	4/Y
Phosphate, Total	1/M	1/Y	4/Y
Organic Chemical			
Carbon chloroform extract	4/Y	-	4/Y
Methylene blue active subst.	4/Y	-	4/Y
Total identifiable chlorinated hydrocarbons	4/Y	1/Y	4/Y
Phenols	4/Y	1/Y	-
Oil and grease	1/M	1/M	-
Biological			
Total coliform	1/M	1/M	1/M
Fecal coliform	1/M	1/M	1/M
Benthic invertebrates	4/Y	-	-

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[a] Sampling frequency; 1/M is equivalent to once per month, 4/Y is four times per year, etc.

Table 14-2

BASIC WASTEWATER EFFLUENT PROGRAM[a]

Parameter	Effluent Type				Sample Type	
	Municipal		Industrial		24-hr Composite	Grab
	Minor	[c]Major	Minor	[d]Major		
Biochemical oxygen demand	1/D	1/D[b]	1/D	1/D		✓
Chemical oxygen demand	-	1/W	1/D	1/D	✓	
Total suspended solids	1/D	1/D	1/D	1/D	✓	
Settleable solids	1/D	1/D	1/D	1/D		✓
pH	1/M	1/D	Continuous	Continuous		✓
Dissolved oxygen	1/M	1/D	1/M	1/D		✓
Sulphide	1/M	1/W	1/M	1/W		✓
Ammonia	1/D	1/D	1/D	1/D		✓
Nitrite	1/M	1/W	1/M	1/W		✓
Nitrate	1/M	1/W	1/M	1/W	✓	
Kjeldahl nitrogen	1/M	1/W	1/M	1/W	✓	
Orthophosphate	1/M	1/W	1/M	1/W	✓	
Phosphate, Total	1/M	1/W	1/M	1/W		✓
Oil and Grease	1/W	2/W	1/D	1/D		
Residual chlorine	Continuous	Continuous	-	-		
Total coliform	1/D	1/D	1/M	1/W		✓
Fecal coliform	1/D	1/D	1/M	1/W		✓
Acute toxicity TLM	1/M	1/W	1/M	1/W	✓	

[a] Parameters to be measured and sampling frequency should be established for each discharge on a case-by-case basis after analyzing actual and potential constituents of wastewater effluent.

[b] Sampling frequency - see footnote Table 14-1.

[c] Minor municipal discharge <3MGD

Major municipal discharge < 3MGD

[d] Minor industrial discharge<1MGD

Major industrial discharge<1MGD

discharge of pollutants has been achieved; (d) an estimate of the environmental impact, the economic and social costs necessary to achieve the objectives of the Act, the economic and social benefits of such achievement and an estimate of the date of such achievement; and (e) a description of the nature and extent of non-point sources of pollutants and recommendations as to the programs which must be undertaken to control them, with estimates of cost.

Information with which to develop an Annual Water Quality Inventory will be obtained primarily from the data gathered under surveillance and monitoring programs.

Laboratory Support and Quality Assurance

To be effective, a water quality management program must be based on accurate and valid data. This in turn requires that adequate physical facilities and professional capabilities be available for the collection, processing and analysis of physical, chemical and biological water and wastewater samples. Standardization of methods for analysis will be essential, and a program for certification and periodic checking of non-State laboratories should be implemented.

Data Storage, Retrieval and Reports

The surveillance and monitoring program set forth above will generate considerable data. These data must be placed in usable form for storage and retrieval, otherwise their value is lost. The data will be used for compliance checking, assessment of progress in water quality control in planning for water quality and resources management and to satisfy the requirements for data reports imposed by PL 92-500.

The magnitude of the problem of the data handling, storage and retrieval, of routine data checking and the preparation of routine data summaries and reports leads directly to consideration of electronic data precessing methods. This type of system is amenable to receiving, checking, storing and retrieving data and, through programming, it can be used to carry out routine data manipulation and prepare data summaries.

It is recommended that the Division of Health establish, for its own use, a system for standardization of data input formats. The data to be submitted to EPA are required to be in a format suitable for direct insertion into EPA's STORET data-handling system.

All data inputs must be checked carefully; a single erroneous or mislocated data entry will invalidate long-term water quality averages and severely limit the usefulness of the monitoring system.

AREA DESIGNATION FOR 208 PLANNING

It is recommended that the Standard Metropolitan Statistical Areas of Salt Lake City and Provo-Orem be considered for designation as 208 planning areas in order to develop a regional management board with authority:

1. to identify those agencies necessary to carry out the basin or area-wide plan, e.g., identifying the costs, the necessary financing, the interim-time periods, and the economic and environmental impact of the plan;
2. to provide, on an area-wide basis, control or treatment of all point and non-point pollution sources, including in place or accumulated pollution sources;
3. to establish construction priorities for treatment works with time schedules for initiation and completion of work;
4. to regulate the location, modification, and construction of any facilities within the area which may result in any discharge in such area;
5. to assure that any industrial or commercial waste discharge into any treatment works meet applicable pretreatment requirements; and
6. to identify non-point sources of pollution, e.g., urban storm runoff and agriculture return flows, and set forth procedures and methods (including land use requirements) to control such sources.

AREA DESIGNATION FOR 201 PLANNING

Each area served by sewerage agencies in the basins may be 201 planning areas with regard to sewage collection and conveyance facilities as well as treatment facility projects necessary to comply with effluent and stream quality standards.

In addition, areas affected by consolidation recommendations as given in this plan must include the total consolidation area within the 201 planning boundaries for any major enlargement or upgrading of treatment facilities.

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